Agricultural Research in South Dakota

Seventieth Annual Report
July 1, 1956 to June 30, 1957

South Dakota Agricultural Experiment Station
Max Myers, Director

South Dakota State College
of Agriculture and Mechanic Arts
Brookings, South Dakota
Letter of Transmittal

President John W. Headley
South Dakota State College

Dear President Headley:

It is a privilege and a pleasure to present the 1956-57 annual report of the Agricultural Experiment Station at South Dakota State College. This report is the seventieth to be published in accordance with the Act of Congress approved March 2, 1887, establishing and regulating experiment stations.

Included in this report are summaries of every project underway at the Station, 133 in all. Nearly every phase of agriculture and home economics is covered in the station’s projects.

During the past fiscal year, many important steps were taken to further improve the service of the Station to the people of the state. The 1957 Legislature authorized the leasing of a 20-acre plot near Presho for the South Central Research Farm and work is well underway. This brings the total number of research sites in the state to 17; in addition there are numerous experimental plots on private farms.

On behalf of the station staff, I would like to express our appreciation to the college administration, the State Legislature, and the people of the state for the added support given to the Station’s research activities.

Sincerely,

[Signature]

Director, Experiment Station
Forward

Here is a summary of the 133 projects underway at the Agricultural Experiment Station. These projects cover many phases of farming, ranching, and home life.

Some projects deal with farm business management; livestock production; crop production; dairying; and poultry production. Others cover insect and disease control; rural life and education; foods and clothing; and marketing of farm products.

Although the types of projects are varied, they all have one goal—to find answers which you can use to make life better for you.

This is the seventieth annual report of the Experiment Station. During the past 70 years, the Station has grown from five departments with a handful of men to 13 departments and more than 150 skilled scientists, all studying ways to overcome farm and ranch problems.

If, while going through this report, you see any projects on which you would like more information, feel free to write to the project leader, stating your wishes. And if you cannot find a project dealing with a production or marketing problem that you face, write and tell us about that, too. That is how many of our projects originate.

Remember, there is only one purpose for an experiment station—to serve you.
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Handling, Storage, and Feeding of Grass Silage with Comparison of Labor Requirements, Costs, Feeding Values, and Losses in Six Different Methods of Storage—A. Structural Requirements and Performance of Above-Ground Trench Silo

Various means of storing grass silage (above ground trench, covered stacks) were employed again in 1956 to study their relative performance. Extensive measurements of silage temperatures in the various silos and stacks were made by means of thermocouples. These temperatures were related to silage quality with and without covers and added preservative. Higher quality accompanied lower temperatures and the addition of preservatives resulted in lower temperature. Covered silos also showed lower temperatures than uncovered.

Eight pilot silos (3,500 pound capacity) were used to obtain closer control of weight loss during the curing process. Experiments were conducted on covered and uncovered silos as well as chemical treatment and no chemical treatment. Silo covers showed a greater ability to prevent weight loss.

Sidewall pressure measurements were continued during 1956. A comparison of unit pressures on vertical and sloped walls was made and the greatest pressures were found to be exerted on the sloped wall.

All concrete floors in the above ground test silo were found to be in good condition. (Project 237. Leader: Harvey G. Young, Agricultural Engineering Dept.)

Crop Drying and Conditioning

Bin Site Phase: September 1956 the bin site tests on aeration of wheat in long time storage were terminated. The third and final year's temperature readings and moisture sample records were tabulated. The results were again consistent in favoring the cupola ventilators and the 50 c.f.m. fans as compared with fans of 100 or 200 c.f.m. on the 3,000 bushel steel bins of wheat. A three year summary report will be published and the project closed.

Picker-Sheller Corn Harvest Phase: Three types of picker-shellers were operated in the tests during the 1956 corn harvest season. All machines shelled in a satisfactory way after the moisture was below 20%. Greatest loss continues to be at the snapping roller rather than the sheller. The corn was dried by the cold air method which has proved to be satisfactory for the third straight year. Machinery is available for use in one more season for this work. (Project 246. Leaders: H. H. DeLong and Eugene Doering, Agricultural Engineering Dept.)

Sprinkler Irrigation Possibilities in South Dakota

New types of sprinklers are being developed and improved to help overcome the labor costs. Considerable work was done on this project to determine the application efficiency of the high pressure "giant" type sprinkler heads. A fire which destroyed much of the equipment of this department also destroyed
the field data of this project before complete analysis was made. However, it was found that these sprinklers are not well adapted to this area.

Initial work was done on a boom type sprinkler which has several nozzles on two rotating booms, each boom about 70 feet long. This machine covers an area up to 3 acres with water with each setting. It appears that this approach to cutting down on labor costs in irrigating tall crops such as corn has possibilities.

Timeliness of irrigation and water requirements of crops is a continuation study. Corn, soybeans, alfalfa, and some horticulture crops are being studied. (Project 192. Leader: J. L. Wiersma, Agricultural Engineering Dept.)

Possible Toxic Effect on Plants of Iron Laden Water Which Is Transported Through Aluminum Pipe for Sprinkler Irrigation Purposes

The experiment was set up as a randomized block using sprinkler irrigation with galvanized and aluminum pipe, surface irrigation, and a non-irrigated check plot. The crop grown was corn.

Due to very timely rains, the corn leaves never did get a very heavy coating of iron and no significant difference in corn yields appeared due to the various means of irrigation.

The experiment will again be conducted during the summer of 1957 to see if there appears a depressing effect of corn yields on plants with heavy coating of iron.

The well water used for irrigation during the summer of 1956 on the experiment contained 18.8 p.p.m. iron. The same well will be used in the summer of 1957. (Project 281. Leaders: V. Flesher and H. H. DeLong, Agricultural Engineering Dept., and C. W. Carlson, Poultry Dept.)

Electric Floor Plate Brooder

The first year's tests of the floor plate brooder showed significant savings in electric power. The first model of plate brooder constructed consumed 40% of the electric power as compared to the bare heat lamps, and 60% as much as the over head type of electric heating element. The brooder did not produce enough heat, however, for February weather conditions.

Fire destroyed the brooder and all temperature and air velocity instruments in January 1957 and no equipment was available for the spring season of 1957. By July 1 most of the repurchasing of material and instruments will be completed. The tests can be resumed in the brooding season of the spring months, 1958. (Project 280. Leaders: V. Flesher and H. H. DeLong, Agricultural Engineering Dept., and C. W. Carlson, Poultry Dept.)

Application of New Materials and Design in Farm Buildings

Work continued on above ground and trench silo structures for the use in the storage of silage. The wood flooring used on side walls remained in excellent condition as did the concrete panels of various concrete mixes and aggregates used on the silo floors. Sloping side wall structures have given better results than vertical side walls.

Pentachlorophenol treated fence posts remained in excellent condition in the fifth year of use.

Close contact on yields of block per cubic yard of material of light aggregate (expanded shale) was continued with the block manufactured within the state. (Project 203. Leader: Dennis L. Moe, Agricultural Engineering Dept.)

Ventilation of Poultry House by Use of Electric Fans, Heat Exchangers, and Dehumidifiers

The refrigeration equipment for the heat exchanger, dehumidifier, and sum-
mer cooling unit was put into operation at Highmore prior to the winter of 1956-57. Only a limited amount of data was obtained during the winter, however, because of freezing around the evaporator, excessive dust accumulation, and mechanical difficulty. The unit was brought back to Brookings in April for redesign and repair prior to installing it for summer cooling. (Project 232. Leader: Donald D. Hamann, Agricultural Engineering Dept.)

Also see:
Farm and Home Water Quality, page 48

Agronomy Projects

Crops and Soils

Breeding and Testing of Barley for South Dakota and Upper Midwest Conditions

A new high yielding barley named Liberty was released in the spring of 1957 by the South Dakota Experiment Station. It was released as a "barley" but preliminary testing indicates probable acceptance as a malting barley. An intensive breeding program with barley was initiated early in 1957 in an effort to increase resistance of good agronomic types to smut and rust and to improve heat tolerance and straw strength while maintaining or increasing yield potential.

Work on winter barley was begun during 1956-57. Selections in types showing winter-hardiness and satisfactory agronomic characteristics will be made during 1957 and these will be incorporated into a winter barley breeding program. (Project 303. Leaders: P. B. Price and D. Harpstead, Agronomy Dept.)

Breeding and Testing Wheats

Purified selections of superior winter wheat progenies were made in 1956 and planted at Brookings and Highmore. Winter survival has been excellent and a rapid increase of the best lines appears certain. Selections of excellent winter hardiness range in maturity from types earlier than Nebred to later than Min- ter. Preliminary quality tests on the original progenies have been very satisfactory.

Extensive segregating populations of spring wheat crosses were grown at Brookings and Newell in 1956. The crosses involve good quality varieties of adapted type, notably Rushmore, Lee, and Selkirk, with varieties of very high levels of disease resistance, and involve crosses and backcrosses.

A crossing program to improve the heat resistance and test weight of Selkirk wheat is carried along with the other breeding work. Crosses have also been made to improve the quality of some wheats of very desirable agronomic type for South Dakota. A large scale study on the inheritance of mixing tolerance—a major quality component—is now in F3 and F4 stages. (Project 181. Leader: V. A. Dirks, Agronomy Dept.)
Breeding and Testing Oats, Flax, and Rye for South Dakota Conditions

Alternative ways of utilizing oats to increase their per acre value to the farmer were studied in 1956. In southeastern South Dakota, drouth-and heat-damaged oats, a total failure for grain production, was found to produce from $\frac{1}{2}$ to 1 ton of harvested oat hay per acre. This hay would be worth $8 to $15 as forage. Rate of seeding had a very important effect on ability of oats to produce grain. Early oats produced highest yields at light seeding rates, late oats at heavier seeding rates under 1956 conditions. In northeastern South Dakota, Garry was the high yielder because of lateness and disease resistance. Ransom was hurt by extreme June heat. Crosses between early and late oats differing in heat resistance and yielding ability have been made and are being studied.

The increase of an early flax strain for future release to farmers will make available a type of rust resistance presently available only in late maturing flax. Screening of 120 new strains of flax for agronomic type and yielding ability was accomplished.

No change is anticipated in the demand for rye varieties. Winter hardiness is very closely associated with high average yields. Tetraploid types available are not sufficiently hardy for South Dakota conditions. (Project 25. Leader: D. Harpstead, Agronomy Dept.)

The Breeding of Superior Field Corn Hybrids

During the past year two new hybrids were released. One, South Dakota 420, is designed to supply the need for corn with a maturity in between the two previously released hybrids, South Dakota 400 and South Dakota 604. The other, South Dakota 622, is later than South Dakota 604 and will be of value further south in the state where no currently produced South Dakota hybrid is adapted.

Hand pollination work was initiated on the Experimental Farm near Menno, South Dakota. Dry weather, however, caused very poor pollination in many cases. Yield trials of experimental hybrids at Brookings and at locations elsewhere in the state indicated that new hybrids are on the way. For example, on the Northeast Experimental Farm near Watertown, 19 out of 46 unreleased hybrids outperformed the best of three commercial checks.

Recently, experiments have been centered on the effects of the drug colchicine, with efforts being directed toward ascertaining whether this drug may become a useful tool in corn breeding. Drought and disease resistance are also major goals in corn work in South Dakota. Cooperative work is being carried on with Plant Pathology toward the development of more disease free hybrids. (Project 66. Leaders: D. B. Shank and D. E. Kratochvil, Agronomy Dept.)

Breeding and Testing Forage and Grain Sorghums and Sudan Grass

Due to drought the past season, there was a very large increase in sorghum acreage planted. Sorghums stabilized greatly the feed grain production in the state as a very large corn acreage failed to produce due to the drought.

Adaptation yield trials on 67 commercial sorghum varieties and Experiment Station strains were harvested at eight locations. The results for those commonly grown by farmers and ranchers are shown in the table. (Project 61. Leader: C. J. Franzke, Agronomy Dept.)

Testing Corn Hybrids in South Dakota

Fourteen yield tests, each containing corn hybrids being used by South Dakota farmers in the area represented by the trial, were planted in 1956. Although severe drought conditions prevailed throughout many parts of the
state, all but two of the tests were harvested. From 20 to 40 entries were included in each trial.

Information obtained included yield and moisture content of the corn at harvest, the latter being indicative of relative maturity. Lodging was taken on plots when possible. Average performances were calculated for entries including more than one year. The results obtained have been published in South Dakota Agricultural Experiment Station circular 134. (Project 151. Leaders: D. E. Kratochvil and D. B. Shank, Agronomy Dept.)

Breeding and Testing of Soybeans, Sunflower, Safflower, and Castor Beans for South Dakota

Soybean varieties grown in the northeastern part of the state yielded as follows: Chippewa, 24.0 bu.; Grant, 24.5 bu.; Mandarin, 20.8 bu.; and Capital, 20.6 bu. At the Station at Brookings, Chippewa yielded 20.3 bu.; Grant, 20.4 bu.; Mandarin, 15.5 bu.; and Blackhawk, 15.5 bu. per acre. The two recent soybean releases, Chippewa and Grant, are resulting in more stabilized and higher yields of beans for the producer.

Seventy-eight strains of sunflowers, seven strains of safflower, 32 strains of castor beans, and 28 lines of millet are being evaluated. These crops are being studied for suitable agronomic characters and their possibility as a special crop for South Dakota. (Project 148. Leader: C. J. Franzke, Agronomy Dept.)

Breeding and Testing of Forage Legumes

One hundred fifteen pounds of breeder seed was produced of a synthetic strain of alfalfa (designated H2-Syn 1), a wilt and leafspot resistant strain that is exceptionally winter hardy and able to withstand grazing. (Figures 1 and 2.) Some of this seed was used for establishing Foundation fields, and some for establishing experimental grazing trials at six locations in eastern South Dakota to compare “H2” with other improved varieties for persistence.

The basic clones of two experimental synthetic strains of the root-proliferating alfalfa are being established in isolated seed increase plots in the current year. One of these strains has been selected for leafspot resistance and aggressive creeping behavior; the other strain has been selected to include wilt resistance.

Through cooperation with Station Biochemistry Department, several alfalfa plants both high and low in total saponin, the chemical agent believed to be causally associated with ruminant bloat, have been found in the breeding material.

All standard and new strains currently available of alfalfa, red clover, sweet clover, and birdsfoot trefoil are under

1956 Grain Yields of Sorghum Varieties at 8 Locations

<table>
<thead>
<tr>
<th>Variety</th>
<th>Brookings</th>
<th>Highmore</th>
<th>Cottonwood</th>
<th>Newell</th>
<th>Eureka</th>
<th>Hitchcock</th>
<th>Water-town</th>
<th>Menno</th>
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<td>47.5</td>
<td>7.1</td>
<td>28.6</td>
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<td>52.0</td>
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<td>Martin</td>
<td>40.2</td>
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<td>1.7</td>
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yield trials throughout the state. Also data are collected for each strain for winter hardiness, its ability to become established, total vigor, disease and insect reactions, maturity, and seed set. Over 100 lots of alfalfa seed sold in South Dakota are tested for trueness-to-type and 27 different lots of Vernal. (Project 74. Leader: M. W. Adams, Agronomy Dept.)

The Genetics of Reaction of Alfalfa to Diseases of the Blackstem Complex

Several fungi and at least one bacterium appear to be involved in the blackstem disease complex of legumes. By isolation and inoculation tests it has been established that the fungi Phoma herbarum var. medicaginis, Cercospora zebrina, and a Colletotrichum species are causal organisms; in addition a bacterium, Pseudomonas medicaginis, produces overlapping stem symptoms.

Field and greenhouse screening tests using the fungi on both diploid and tetraploid alfalfa have shown that (1) genetic differences exist in reaction to these organisms at both diploid and tetraploid levels, (2) the differences are moderately to highly inheritable, and (3) some of the isolates of Phoma differ in pathogenecity.

Two series of all-combination crosses among diploid plants of eight diverse sources have been set up, and initial screening tests on the first hybrid generation have been commenced. (Project 302. Leaders: H. Geise and M. W. Adams, Agronomy Dept.)

Physiological Investigation in Alfalfa

Major emphasis is being placed on investigations regarding the physiological basis for resistance and susceptibility to low and high temperatures and to water stress. Promising leads in the organic nitrogen metabolism and the respiratory mechanism in alfalfa are underway. Since this work has been underway for about one year, no definite conclusions are possible. (Project 295. Leader: C. R. Swanson, Agronomy Dept.)

The Breeding and Testing of Superior Grasses Adapted to South Dakota

Superior varieties are being selected in the four grasses, smooth bromegrass, intermediate wheatgrass, crested wheatgrass, and a native warm season grass, switchgrass. Preliminary increases for testing are being made of varieties synthesized from selected plants. The following characteristics are among those evaluated during selection: forage yield, leafiness, seed yield, leaf spot resistance, and root rot resistance.

Material from crosses between winter wheat and intermediate wheatgrass gives promise of a large seeded grass. Selection of winter hardy plants from these populations is being made.

Screening tests for disease resistant types are carried out in the greenhouse.

Figure 1. Comparative persistence and vigor of two strains of alfalfa after 2 years of grazing by sheep, Brookings, 1956. South Dakota Experimental strain, left, and Rhizoma alfalfa, right.
and these results checked in the field. Introduced species and new varieties are tested in the field under the various climatic conditions in the state. Test plots are situated at Brookings, Menno, Watertown, Highmore, Eureka, and Cottonwood. (Project 182. Leader: J. G. Ross, Agronomy Dept.)

The Evaluation of Forage Legumes and Grasses for Adaptation to the North Central Region

Foreign introduction of bromegrasses and wheatgrasses and also native collections of switchgrass are being tested at Highmore and Brookings for winter hardiness and drought and disease resistance. (Project 297. Leader: J. G. Ross, Agronomy Dept.)

Pasture Investigations in South Dakota

The pasture trials started in 1953 were grazed the fourth season with Aberdeen Angus yearlings. Included in the trials were bromegrass, alfalfa-brome, sweet clover-rye, and soybean-sudan pastures. Each was fertilized to maintain good soil productivity. The bromegrass and alfalfa-brome pastures were divided in half so the livestock could be rotated every 2 or 3 weeks for better utilization and management of the forage. The livestock on the sweet clover-rye and soybean-sudan pastures were not rotated.

The amount of forage consumed by the livestock was determined by clippings from plots outside and inside of protected cages. Forage clippings representing an estimate of amount consumed were as follows in 1956: brome, 2.26 tons; alfalfa-brome, 2.46 tons; sweet clover-rye, 1.6 tons, and sudan-soybeans, 2.42 tons per acre. Summary of the 1956 beef gains from these pastures were as follows: brome, 295 pounds; alfalfa-brome, 346 pounds; sweet clover-rye, 40 pounds, and soybeans-sudan, 126 pounds per acre. Because of the hot dry season of 1955 sweet clover failed to develop a stand and only 30% stand of rye was present. (Project 225. Leaders: W. W. Worzella, Agronomy Dept., and L. B. Embry, Animal Husbandry Dept.)

Weeds and Weed Control

The use of chemicals, competitive crops, and cultivation when used alone and in various combinations was...
studied to learn the most practical methods of controlling and eliminating leafy spurge, Canada thistle, perennial sow thistle, and Russian knapweed. The results obtained on the spurge farm were reported in *South Dakota Farm and Home Research*, Vol. VIII, No. 2, pp. 8-13.

Results from the thistle farm indicate that over 90% of Canada thistle or perennial sow thistle can be eliminated in one year while raising a crop of small grain. The most effective treatments consisted of spraying in the grain with 2,4-D followed by plowing the stubble in August. The subsequent treatment could be two fall cultivations or an application of 2,4-D during late September to thistles that emerged on the plowing. The following year corn that was sprayed once allowed some thistles to come back, but corn that was sprayed twice (mid-June and early September) reduced the stand, while corn sprayed in June, cut for silage, and fall-plowed held its own.

At the station at Brookings it was learned that (1) Canada thistles must be in bloom 10 days before viable seeds are produced, (2) perennial sow thistle seeds are viable 7 days after blooming, (3) both thistles are cross pollinated, (4) they are pollinated by bees but not by wind currents, and (5) neither species will germinate if the seed is over one-half inch deep in the soil.

Foxtail growing in corn was held in check about 2 weeks when sprayed pre-emergence with CDAA, and about 50% of it was killed when sprayed with DNBP at the time the corn was in the two-leaf stage. (Project 32. Leader: L.A. Derscheid, Agronomy Dept.)

Soil and Crop Management Systems for Improved Soil Productivity

A farmer in Tripp county, South Dakota, lost 200 acres of small grain in the spring of 1955. He had placed 20 pounds of N as urea with the seed. It was estimated that the stand was reduced 75% or more. Urea from that same shipment was placed in comparisons with ammonium nitrate and treble superphosphate on winter wheat that fall. The fertilizer in all cases was placed with the seed. The stand on the plots receiving 20 pounds N was an average 26% of the stand on the check plots. (Figure 3.) Neither ammonium nitrate nor treble superphosphate had an appreciable effect on stand.

An analysis was made of the urea used and it was found to contain 12.5% biuret. An experiment on spring grain in 1956 followed where urea materials with differing biuret contents were compared to ammonium nitrate and treble superphosphate. Urea was found to be definitely more unfavorable than either of the other two fertilizers when placed with the seed. The urea materials with the higher biuret content were much more unfavorable than those with a low biuret content. However, urea containing only 0.15% biuret caused more damage than ammonium nitrate to germination. Very likely the evolution of ammonia upon hydrolysis of the urea compound is rapid enough to hinder germination, this being in addition to the caustic effects of the biuret. (Project 4. Leader: B. L. Brage, Agronomy Dept.)

The Effects of Mineral Fertilizers, Crop Residues, Legumes, and Grasses on the Fertility and Physical Properties of Soils

A major portion of the soil fertility research of this project is concerned with nitrogen. Research is underway on how to supply adequate nitrogen to growing crops by means of legume rotations, nitrogen fertilizer, and crop residues. The effects of time of fertilizer application showed little or no influence on the yield of small grain as shown in the table.

Straw has a wide carbon-nitrogen ratio and may cause a depression of
available nitrogen when returned to the soil. An experiment is underway to determine how much nitrogen should be applied to prevent nitrogen tie-up when various amounts of straw are plowed under. The results show that the plowing under of straw without nitrogen fertilizer depressed the yield of wheat. For all straw treatments, the application of 25 or more pounds of nitrogen per acre produced significant increases in the yield of wheat. (Figure 4.) (Project 46. Leader: L. F. Puhr, Agronomy Dept.)

The Investigation of Soil Problems in Relation to Irrigation Developments in Sub-humid Areas

Rotation, grass seed, and corn fertilizer experiments were continued in 1956 at the Redfield Development Farm. A severe hail storm ruined most crops in the latter part of June.

Water quality experiments at the Shadehill Development Farm have been conducted since late in 1952. The reservoir water is hazardous to soil structure because of high sodium and high bicarbonate content. The sodium content of the water has caused accumulation of sodium in the soil clays, which, when severe, makes the soil behave as a "slick spot" soil. The untreated reservoir water has caused the sodium accumulation in the soil to be near the danger point.

Experimental plots irrigated with water to which gypsum has been added have experienced considerably less accumulation of sodium, and it appears that this gypsum addition may be necessary to make the water safe for continued use. It is likely that a firm answer to this problem will be in sight with another year’s work.

Irrigation experiments in Yankton County showed a considerable yield increase for proper combination water management and fertilizer practices in the dry season of 1956. Corn and soybeans produced yields of 137 and 32 bushels per acre, respectively, with optimum combinations of irrigation and fertilizer practice. The soils require rather large applications of nitrogen with moderate amounts of phosphorus, and irrigation in such fashion that no great moisture stress exists before the

<table>
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<th>Spring Application</th>
<th>Deuel Co. Fall Application</th>
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The Importance and Evaluation of Physical Properties of Soil as Influenced by Soil Management Practices

Soil structure investigations on the Redfield Crop Rotation Experiment were completed this year. On the surface soil, the bulk density, total porosity, and moisture content at 0.03 a.t.m. tension were not affected by rotation, fertilizer, or irrigation treatment. However, the moisture content at 0.06 a.t.m. tension was significantly lower on the irrigated land than on the dry land. Irrigation has improved the soil structure slightly, probably as a result of greater decomposition and return of organic matter to the soil.

Soil moisture measurements were made at Brookings on alfalfa, corn, oats, and flax throughout the growing season. Alfalfa used 19.2 inches of water from May 2 to September 22. Corn, oats, and flax used 17.9, 17.0, and 17.4 inches, respectively, during the same period. The rainfall received during this period was 16.9 inches. This water that was used in excess of the rainfall came from soil moisture stored during previous seasons. The fallow land retained only 18% of the rainfall received during the period May 2 to September 1.

Investigations have been conducted on the possibility of reducing transpiration of water by plants with film-forming materials. The materials that have been used are plastic, latex, and silicone. Reduction in excess of 50% have been attained under greenhouse conditions. Some detrimental side effects have developed with the use of film-forming materials and these are being investigated for possible means of improvement. (Project 269. Leader: J. R. Runkles, Agronomy Dept.)

The Development of Soil Testing Procedures and Program for Determining the Soil Fertility of South Dakota

The soil testing laboratory tested 7,000 soil samples during the past year. More than 89% of the samples tested were submitted by or for farmers.

The laboratory cooperated in the expanded TVA demonstration program by testing the soils from the fields involved in the demonstration. Cooperation was also extended to the Farm and Home Development Program being started in Deuel County.

Experiments were established to determine the effect of sampling time on the soil test results. This sampling pro-

Figure 4. Effect of Nitrogen on Straw Treatments for Wheat.
gram will be continued during the coming year. Experiments with potassium fertilization for soil test fertilization yield correlation purposes have been established on areas most likely to give a potassium response.

More than 175 water samples were tested to determine the quality of the water for irrigation purposes. This is more than two times the number of water samples received during the previous year.

The laboratory and record procedures have been reorganized to make it possible to use machine records in the summarization of soil test data. A start has been made to place the laboratory records on IBM cards. (Project 172. Leaders: P. L. Carson and R. C. Dodge, Agronomy Dept.)

The Surveying of Soils in South Dakota

Two soil survey reports were prepared for publication: (1) Hand County, Soil Survey Series No. 3, and (2) Hand County Documentary Soil Survey Report.

The Soil Survey Series is designed for farmer use and contains aerial photo soil maps at a scale of 8 inches = 1 mile of individual farms along with soil management information, yield tables, and short soil descriptions. The documentary report will contain maps of the entire county, with complete soil descriptions and soil management information. This report is designed for users desiring information for the entire county.

The State College crew mapped approximately 64,000 acres in Hand County and about 6,000 acres in Dewey County. About 140 complete profile descriptions were prepared for South Dakota soils. The profiles were sampled in Hand County and 20 in Minnehaha County for chemical and physical analyses by the SCS Laboratory in Lincoln, Nebraska. (Project 183. Leaders: F. C. Westin, G. J. Buntley, E. M. White, L. P. Wilding, and R. G. Bonesteel, Agronomy Dept.)

Cultural Practices for Improving the Efficiency and Stability of Crop Production in South Dakota

The new research farms located near Menno and Watertown are now in their second crop year. Experimental work underway includes (1) minimum tillage or “once over tillage” with corn, (2) a comparison of different nitrogen fertilizer carriers—gas, liquids, and solids—for corn and small grains, (3) a comparison of legume nitrogen to commercial nitrogen fertilizer to increase crop yields, (4) experiments to determine which is the most efficient method of commercial fertilizer use—a small amount applied every year or a large amount applied once in 5 years, (5) determine effect on grain crop yields from plowing under stands of alfalfa of varying ages, and (6) effect of wide row spacing and inter-tillage to obtain seed crops of alfalfa and bromegrass.

In addition, four new experiments started in the spring of 1957 are: (1) how to manage alfalfa in a rotation to take advantage of its desirable qualities as nitrogen fixation, yet avoid the pitfalls often incurred in its use such as soil moisture depletion, (2) determine the most efficient method of fertilizing corn—plow down, disk in, hill applications with side dressing later, or deep application 12 to 18 inches below the surface, (3) an experiment on use of soil moisture by different crops, and (4) heavy rates of fertilization and weed control of flax. (Project 256. Leaders: F. Shubbeck and Q. Kingsley, Agronomy Dept.)

Also see:

Nutritive Values of Grasses and Hays of the Northern Great Plains, page 14
Irrigated Pastures in Western South Dakota, page 18
Bloat in Ruminants, page 21
Winter Feeding and Summer Grazing Studies with Range Ewes

Four hundred range ewes were permanently allotted to each of four summer pastures in 1952. Three pastures have been grazed heavily, moderately, and lightly; the fourth is a four unit (six week) rotation system, moderately grazed. The summer grazing season is from May 1 to November 1.

In addition to the summer grazing treatments, 25 ewes from each summer lot have been permanently allotted to one of the following four winter treatments: Lot 1, 0.33 pound 40% protein supplement winterlong; Lot 2, 0.33 pound 20% protein supplement winterlong; Lot 3, 0.33 pound 40% protein supplement the last 6 weeks of gestation only; and Lot 4, 0.66 pound 20% protein supplement winterlong. Ewes have been grazed on winter range as a band and have been cut and fed their respective rations daily. Hay has been fed only when the ground has had a heavy snow cover.

Ewes and lambs are brought in to headquarters as the lambs are dropped (about April), and ewe and lamb weights are recorded. Ewes and lambs are weighed monthly throughout the summer and ewe weights are taken monthly in the winter. Registered polled Rambouillet rams are purchased every two years.

Bred range ewes fed two-thirds pound 20% protein supplement winterlong (November 1, 1955 through March 30, 1956) produced single lambs which averaged 0.6 pounds more at birth than ewes fed only one-third pound 40% protein supplement the last 6 weeks of gestation. Twin lambs from ewes fed the higher ration (Lot 4) were 1.3 pounds heavier at birth than twins from ewes fed the lower supplement. At weaning, single lambs from ewes fed in winter lot 4 averaged 86.8 pounds, while those from ewes fed in winter lot 3 averaged only 80.4 pounds. Ewes in winter lot 3 failed to raise a set of twins through weaning. Twins raised as singles in winter lot 3 averaged 2.0 pounds less at weaning than twins raised as singles in winter lot 4.

Ewes fed the higher level of supplementation weaned 41% more lambs than ewes fed at the lower level. Similar results were obtained when other measures of the experiment were compared: (1) a greater percentage of lambs born per number of ewes completing the trial; (2) higher lamb survival; (3) greater ewe weight gain through the winter.

Bred ewes on open range throughout the winter must be kept in good condition, especially as lambing approaches. After lambing, the survival and growth of the lambs will depend, to a great extent, on the condition of the summer range.

Ewes on the lightly grazed pasture in the summer of 1956 weaned lambs that weighed an average of 86 pounds, while ewes on the heavily grazed pasture weaned lambs weighing only 73 pounds (October 4).
The level of winter supplementation is a most important consideration when ewes come off the summer range in poor condition and/or when the winter range forage is deficient. Condition of the ewes at the end of the summer, the climate of a given year, and many other factors may influence the level of winter supplementation necessary to permit maximum ewe production. (Projects 159 and 177. Leaders: J. K. Lewis, L. B. Embry, and F. R. Gartner, Animal Husbandry Dept., and W. R. Trevillyan, Antelope Range Field Station.)

**Nutritional Studies with Beef Cows Wintered on Range**

Fifty-four yearling Hereford heifers were permanently allotted to three levels of winter vitamin A supplementation with duplicate lots in the fall of 1952. They have been grazed on excellent condition deferred winter range and fed 1 to 1½ pounds per head daily of a 38% protein supplement containing added phosphorus and 0, 1,000, or 3,000 I. U. of vitamin A per 100 pounds of body weight. They were fed the supplement from November 28, 1956, through May 1, 1957. Blood samples were taken at the beginning, about the middle, and near the end of the winter feeding period and these were analyzed for plasma carotene, vitamin A, and phosphorus.

Vitamin A plasma levels during the winter are related to the amount of vitamin A contained in the supplement. No symptoms of vitamin A deficiency have been observed. There were no great differences in the plasma vitamin A and carotene values of blood samples taken November 28, 1956, from cows from heavy, moderate, and light summer grazing. Plasma carotene values of samples taken February 9, 1957, and March 2, 1957, were considerably lower than those taken at the start of the winter feeding period and corresponded to the amount of vitamin A added to the supplement.

This study is being continued with the same cows on the same treatments. (Project 217. Leaders: J. K. Lewis, F. R. Gartner, Animal Husbandry Dept.; O. E. Olson, Biochemistry Dept.; and Frank Whetzal, Cottonwood Range Field Station.)

**Summer Grazing of Beef Cows for Calf Production**

Six pastures at the Cottonwood Range Field Station have been grazed heavily, moderately, or lightly since 1942. Yearling Hereford heifers were permanently allotted to these pastures in the fall of 1952 and dropped their third calf crop in the spring of 1956.

During the 1956 season (May 19 through November 27) cows under heavy grazing lost an average of 153 pounds per head, while cows under light grazing gained an average of 47 pounds. Average corrected weaning weights of calves from heavy, moderate, and light grazing were 368, 418, and 427 pounds, respectively.

Forage production in late summer and fall was quite low. When removed from the summer pastures, the cows from heavy and moderate grazing were noticeably in poorer condition than in past years.

Clipping studies were continued and data was obtained concerning forage production, utilization, plant vigor, and species relationships.

The study is being continued with the same cows on the same treatments. (Project 216. Leaders: J. K. Lewis, F. R. Gartner, Animal Husbandry Dept.; O. E. Olson, Biochemistry Dept.; and Frank Whetzal, Cottonwood Range Field Station.)

**Mineral Requirements and Mineral Supplements for Sheep and Cattle. I. Manganese Requirements for Growing-Fattening Cattle**

A previous experiment indicated a slight improvement in rate of gain
when 30 p.p.m. of manganese was about the same amount of feed in this p.p.m. of manganese. Hereford heifer calves were fed for about 8 months in the experiment. The experiment is being repeated using twin beef calves that appear identical. The twins are started on the low-manganese ration when they weigh about 400 pounds. The low-manganese ration is fed to each pair for 4 months. This 4-month period serves as a uniformity trial and a manganese depletion period. Rather uniform results have been obtained within pairs of twins.

After the depletion period, one of the twins in each pair received 30 p.p.m. of manganese added to the basal ration. The experiment has not been in progress long enough to determine the response to the added manganese. (Project 218. Leaders: L. B. Embry and Dean Radabaugh, Animal Husbandry Dept.; G. R. Gastler and O. E. Olson, Station Biochemistry Dept.)

Nutritive Value of Hay and Grasses of the Northern Great Plains

Steer calves wintered at the North Central Substation on alfalfa hay alone, combination of alfalfa hay and native prairie hay to give 10% protein in total ration, native prairie hay and soybean meal to give 10% protein in total ration, and prairie hay alone made average daily gains of 1.05, 0.67, 0.72, and 0.31 pound, respectively. Similar calves were fed rations composed of alfalfa hay and prairie hay at the Range Field Substation. The four rations fed contained 70, 50, 30, or 10% alfalfa hay. Average daily gains for these levels of alfalfa hay were 0.65, 0.61, 0.48, and 0.20 pounds, respectively. The levels of protein in these rations in order listed were approximately 12, 10, 8, and 6%.

The results of the feeding trials at the Range Field Substation indicate that 10% protein in rations composed of roughages is about the optimum needed for wintering calves. All calves were fed about the same amount of feed in this trial.

The results of the trial at the North Central Substation show that soybean meal and alfalfa hay were approximately equal as a protein supplement to prairie hay. The higher gain on alfalfa hay alone appears to be due to greater feed consumption; prairie hay alone is often low in protein for satisfactory wintering of calves.

Another phase of this project includes a study of feeding value and storage losses of native prairie hay after various years of storage in the open. This phase is only in the second year and more years are needed to determine the effect of length of storage on the feeding value of hay and the extent of losses in nutrients. (Project 120. Leaders: L. B. Embry and Paul Zimmer, Animal Husbandry Dept.; A. W. Halverson, Station Biochemistry Dept.; and J. G. Ross, Agronomy Dept.)

Development of a High Producing Flock of Tailless Sheep

Productivity of the No-Tail flock for 1956 was: 114% lambs born of ewes bred and 90% lambs weaned of ewes bred; average birth weight 10.0 pounds, average weaning weight (120 days) 60.4 pounds. Single lambs weighed 1.3 pounds more at birth and 5.1 pounds more at weaning than twin lambs. Average tail length of all lambs was 1.52 inches, ranging from 0 to 5.5 inches; 34% were tailless, 45% had an inch or less tail at birth.

First cross ewes (all yearlings) out of No-Tail ewes and sired by Columbia, Hampshire, Rambouillet, or Southdown rams produced their first lambs all sired by No-Tail rams. These ewes had tail lengths ranging from 0.75 to 5.75 inches with an average of 4.62 inches. Their lambs had tails ranging from 0 to 5.50 inches and averaging 3.36 inches. Lambs from these ewes weighed
9.6 pounds at birth and 57.5 pounds at weaning. Yearling No-Tail ewes produced lambs weighing 9.4 pounds at birth and 57.1 pounds at weaning.

Purpose of this type of crossing is two fold: (1) to learn the number of backcrosses to No-Tail rams to produce a high percentage of tailless lambs, and (2) to learn what crossing does to lamb and wool production. Obviously (1) must be pursued for at least one or two additional backcrosses, and (2) shows little difference in lamb weights between No-Tails and crosses. (Project 9. Leader: J. W. McCarty, Animal Husbandry Dept.)

The Improvement of Beef Cattle Through Breeding

The study of methods of selection and of inbreeding in beef cattle is continuing and progressing well. A recent study (1) has yielded age correction factors for 18-month weights of beef heifers, (2) has indicated that the effect of inbreeding on weaning weights and 18-month weights are curvilinear, (3) has shown that for the levels of inbreeding studied, the type or conformation of the animal was not affected, and (4) indicates that the most efficient selection of heifers is based on weaning weights, 18-month weights, and 18-month type score.

Another study failed to show any advantage in the feed-lot for lighter colored Herefords as is commonly thought in some areas. Differences between progeny from different sires were much larger than differences between groups based on their color.

The study of dwarfism continues with the use of X-rays and blood tests in an attempt to identify carrier animals. A study of the possibilities of breeding animals resistant to selenium poisoning is also in progress. (Project 167. Leaders: C. A. Dinkel, J. A. Minyard, A. L. Musson, and W. C. McCone, Animal Husbandry Dept.)

Inbreeding, Linecrossing, and Selection Within the Duroc, Hampshire, and Yorkshire Breeds

A fourth generation of selection within the Duroc line with major, but not complete, emphasis on backfat thickness has resulted in no essential change. Although the live probe technique used identifies the less-fat animal, apparently too much associated selection for productivity has cut out potential gains toward leanness. Four of eight original Yorkshire groups have been carried into the second generation of close inbreeding. Performance has been depressed with inbreeding, but these stocks appear to have some possibility of being fair producing inbreds as well as potentially useful in crosses. Gradual introduction of new genes into the Hampshire line by successive topcrosses is being hampered because of limited numbers.

At Eureka, tenth generation pigs of a systematic rotation cross including the Duroc, Hampshire, and Yorkshire breeds, continues to demonstrate this breeding system as efficient for slaughter hog production. (Project 124. Leader: J. W. McCarty, Animal Husbandry Dept.)

Swine Production for the Irrigated Area of Western South Dakota

A small herd (about 15 sows) is maintained for the purposes of demonstrating the efficiency of systematic rotational crossing, testing boars from inbred lines produced at Brookings, and demonstrating good swine production practices.

Pigs produced in 1956 were sired by inbred Yorkshire boars and were the tenth generation of a systematic cross of the Duroc, Hampshire, and Yorkshire breeds. Production from 16 sows was 10.1 pigs farrowed and 7.4 pigs raised per litter. A sample of 23 barrows was slaughtered for carcass evaluation at 165 days of age, weighing 216 pounds. The entire pig crop reached de-
sirable market weight at an age averaging under 6 months. Results support systematic crossing as a good program for the production of slaughter hogs. (Project 132. Leader: J. W. McCarty, Animal Husbandry Dept.)

Reducing Farm-to-Market Losses of Livestock

The extent, magnitude, and economic significance of livestock marketing losses of South Dakota producers is being studied. Particular emphasis is being given to bruising, crippling, death, and shrinkage losses.

Records of dead and crippled livestock have been collected and tabulated on an annual, monthly, and daily basis. These data are being related to season, total receipts, species, method of transportation, point of origin, and climatological factors.

Studies using yearling steers to determine the effects of fasting and extent of in-transit shrinkage on the pattern of shrink recovery are in progress.

Methods are being developed to determine the nature and extent of bruising in slaughter swine. An economic evaluation of bruise losses will be made as the project continues. (Project 265. Leaders: R. M. Luther, Animal Husbandry Dept., and R. H. Kruse, Economics Dept.)

Marketing Roughage

Approximately 300 hay samples were collected from South Dakota farmers during the 1956 season. The physical condition of the hay was noted and a chemical analysis was made to determine protein and moisture content. Price information was received later from the farmers, noting the hay's market price at the time of sale. Preliminary work with data sheets indicates that factors other than quality of hay have had a greater influence on the hay price during the 1956-57 season.

Work is continuing on a more intensive study for a localized area in 1957. By covering a small area more intensively it is believed that the extent of price bias introduced by different areas may be reduced. (Project 267. Leaders: E. DuBose and L. D. Kamstra, Animal Husbandry Dept., and Winston Ullman, Economics Dept.)

The in vitro and in vivo Digestibility of Prairie Hay and Other Forages as Related to the Carbohydrate Components

Samples of brome, alfalfa-brome, sweet clover-rye, and soybean-sudan were collected, representing different cuttings and stages of maturity. Three stages of prairie hay (Western Wheatgrass) were also collected and initial samples were taken of prairie hay to be stored 6 years under various conditions.

Holocellulose fractions were isolated from all samples collected as a means of representing the carbohydrates of plants in a single fraction. Necessary preparations and preliminary in vitro digestions were completed. Analysis procedures have been refined and adaptations made for forage analysis.

Differences in the carbohydrate fractions of the plants used in this study are indicated. (Project 293. Leaders: L. D. Kamstra and L. B. Embry, Animal Husbandry Dept., and A. H. Halvorson and G. F. Gastler, Station Biochemistry Dept.)

Creep Rations for Pigs

Sixty-four baby pigs were removed from their dams at 3 weeks of age to study the value of adding pepsin to creep rations. Rations containing dried skim milk were of an equal value to those that did not contain dried skim milk. There was no value of adding pepsin to either of these rations for 3-week-old pigs.

In another trial pigs weaned at 4 and
5 weeks of age gained faster than those weaned at 3 weeks. A benefit was shown when small pigs in a litter were removed from their dams 1 week later than heavier pigs. (Project 212. Leader: Richard C. Wahlstrom, Animal Husbandry Dept.)

The Effect of Antibiotics and B-Vitamins in Rations for Swine

Various combinations of B-vitamins and antibiotics were fed to 72 weanling pigs that were divided into 12 lots of six pigs each. An increased rate of gain was produced when antibiotics were fed but there was no significant change in growth rate due to B-vitamin supplementation.

In another trial, a combination of Streptomycin and Sulfadiazine gave a growth response when fed at a level of 25, 50, or 100 gm. per ton of ration but no response when fed at 10 gm. per ton level. In a trial conducted during the summer of 1956, chlorotetra cycline elicited as great a growth increase at a level of 10 gm. per ton as it did at a level of 100 gm. per ton. The higher level of antibiotic promoted a greater growth stimulation during the first 4 weeks of the trial but this difference was not maintained at market time. (Project 238. Leader Richard C. Wahlstrom, Animal Husbandry Dept.)

The Amino Acid Requirements of Swine

Feeding of a corn-soybean meal ration containing approximately 0.65% calcium resulted in good growth; however a 5% incidence of parakeratosis was noted. The feeding of this type of ration containing 1% or more of calcium resulted in poorer growth and a 40% incidence of parakeratosis.

Adding zinc to this high calcium ration at a level of 62 parts per million prevented symptoms of parakeratosis and increased growth rate. Where symptoms were already present, zinc supplementation resulted in a marked increase in growth rate and an alleviation of the skin lesions. A more detailed report of this experiment is given in South Dakota Agriculture Experiment Station Circular 137. (Project 251. Leader: Richard C. Wahlstrom, Animal Husbandry Dept.)

Supplementation of Cereal Grains for Swine

A winter dry-lot trial was conducted with weanling pigs being fed shelled corn and protein supplement free-choice. Pigs fed protein supplements containing 10, 20, and 30% of ground alfalfa hay all gained at about the same rate. However, the supplements containing 20 and 30% of alfalfa hay were more economical as less protein was consumed per unit of gain. Another lot of pigs was fed a complete mixed ration with similar results.

In another trial Mo-0-205 oats was shown to be of equal feeding value to light colored oat varieties. The cost of gain was much more expensive when oats were used as the only cereal grain than when a mixture of corn and oats (1.5 to 1) was fed as the cereal grain part of the ration. (Project 268. Leader: Richard C. Wahlstrom, Animal Husbandry Dept.)

Handling, Storing, and Feeding Silage

Keeping Quality and Feeding Value of Silage—Corn silage was stored in an upright silo and in a pile on the ground, about 120 tons in each. Feeding to yearling steers was initiated 3 weeks after the silage had been stored. Forty steers were divided into four lots of ten each and two lots were fed silage from each source of storage. By weighing all silage going into storage and again at the time it was fed, spoilage and weight losses could be measured. The pile of silage furnished feed for a 119-day feeding period while the upright silo produced feed for a 180-day period. Percent of the
weight of silage stored in relation to the amount fed was 87% for the upright silo and 54% for the pile on the ground.

Stilbestrol was superimposed in the feeding of the four lots of steers in such a way that the feeding of 10 mgs. of stilbestrol per head daily could be compared to an original implant of 36 mgs. No difference was observed in rate of gain. However, the stilbestrol-fed cattle had a tendency to grade higher in the carcass than did the implanted steers. (Project 237. Leader: W. C. McCon, Animal Husbandry Dept.)

Storage Losses in Stacked Sorghum Silage—A stack of sorghum silage containing 158 tons was made and feeding started about 1 month later. Three lots of steers which had been used in a trial on the value of diethylstilbestrol implants for grazing steers were fed this silage. They were fed alike and did not receive any further diethylstilbestrol treatment. The pasture diethylstilbestrol treatment increased gains but had no effect on subsequent gains in the feed lot.

Another three lots of steers were also fed the silage. One lot served as the control, one was fed 10 mg. of diethylstilbestrol daily, and one lot was implanted with 36 mg. of diethylstilbestrol. The rates of gain were 2.25, 2.69, and 2.70 pounds, respectively, for the three lots.

Carcass grades and yield were about the same for those fed or implanted with diethylstilbestrol but the control animals graded slightly higher in the carcass but not on foot.

About 65% of the dry matter stored was fed. All moldy silage was fed except near the end of the trial when some had to be discarded. (Project 237. Leaders: L. B. Embry and Dean Radabaugh, Animal Husbandry Dept.; A. W. Halverson and O. E. Olson, Station Biochemistry Dept.)

Irrigated Pastures in Western South Dakota

Cattle and sheep are being pastured on irrigated alfalfa-brome to determine the carrying capacity and the amount of beef and lamb that can be produced per acre.

Forty-seven ewes and seventy-three lambs were pastured on 10.25 acres for 97 days. A few ram lambs were removed before the end of the grazing season. The pastures provided 4,559 pasture days for the ewes and 6,889 lamb pasture days. Assuming two lambs are equivalent to one ewe the carrying capacity of the pasture is eight mature sheep per acre.

The sheep production per acre was 300 pounds; 260 pounds of this was produced by the lambs. The average rate of gain for the lambs was 0.39 pound per day.

At the beginning of the grazing period 20 yearling steers were put on pasture comparable to that of the sheep. During the season (May 21-September 6) four steers died of bloat. The 10.25 acres provided 2,075 pasture days for the steers or carried about 1.9 steers per acre for the season. The steers gained 1 pound per day and produced only 201 pounds of beef per acre. The low rate of gain is partly due to difficulty encountered in getting the steers to pasture at the beginning of the experiment. The steers gained very little for the first 10 days. (Project 229. Leaders: Leon F. Bush, J. K. Lewis, Animal Husbandry Dept.; W. W. Worzella, Agronomy Dept.; and Niel Dimick, U. S. Newell Field Station.)

Effect of Vitamin D Supplementation on Feeder Lambs

Trials were conducted at Brookings and Newell stations. Eight lots of 13 lambs each were fed at Brookings, and eight lots of 20 lambs each were used at Newell. Four treatments were used—control, 500,000 U. S. P. units of vita-
min D, 1 million U. S. P. units of vitamin D injected subcutaneously, and dicalcium phosphate added to the control ration. Each of these treatments was duplicated. Half of the lambs in each lot were shorn at the beginning of the trial. The wool covering may affect the amount of vitamin D produced by irradiation.

There was considerable variation in rate of gain and feed efficiency between treatments. In most comparisons the shorn lambs gained more rapidly than those in wool. On an average, the lambs treated with vitamin D gained slightly faster and more efficiently than the control lambs. However, this was not significant. Little differences were noted between those fed minerals and the control. Carcass quality and dressing percentage varied little among treatments. (Project 282. Leader: Leon F. Bush, Animal Husbandry Dept.)

Feeding Hormones to Growing-Fattening Lambs

Four levels of hormone feeding were used in trials at Brookings and Newell stations with 264 feeder lambs. The treatments used were control, 0.8 mg., 1.2 mg., and 1.6 mg. of stilbestrol. Each treatment was duplicated. The control ration was shelled corn and alfalfa hay, full fed and 0.1 pound protein supplement. In the treated lots stilbestrol was mixed with the protein supplement. The addition of stilbestrol to the ration increased the rate of gain and feed efficiency. There was a trend for the rate of gain and feed efficiency to increase as the hormone level was increased. The daily rate of gain for the lambs receiving 1.6 mg. stilbestrol was 0.36 pound compared to 0.3 pound for the controls. This is a 20% increase in gain; however, neither lot of lambs gained very rapidly. The lambs fed the high level hormone required about 12.5% or 125 pounds less feed per hundred pounds of gain than the controls.

There was little difference between the rate of gain and feed efficiency of lambs fed 0.8 mg. and 1.2 mg. of stilbestrol per day. However, these lambs gained about 10% faster on 9% less feed than the control lambs.

The carcass quality and yield was nearly the same for all treatments. (Project 298. Leader: Leon F. Bush, Animal Husbandry Dept.)

Also see:
Pasture Investigations in South Dakota, page 7
Bloat in Ruminants, page 21
Investigations to Develop a Systemic, Chemotherapeutic Method of Controlling Cattle Grubs, page 30
Selenium Poisoning, page 48

More than 3,000 South Dakota farmers and ranchers attended field days throughout the state during the summer.
Dairy Projects

Dairy Production

Improvement of Dairy Cattle Through Breeding

Two inbred lines of Holstein-Friesian cattle are being developed by sire-daughter and other less close matings. These lines are designated as B and R. When inbreeding coefficients exceed 30%, the inbred lines are to be crossed in order to obtain possible measures of heterosis. These crosses are to be made reciprocally. An outbred control group of females is maintained by artificial insemination randomly to a group of highly proven sires. At present 80 animals are included in the project.

A phase of the project includes the study of production records. During the past year over 1,636 records since 1897 were studied. The number and month of termination and proportion of incomplete records were determined. Factors for conversion of incomplete to an extrapolated complete basis were established. Slightly more than three lactation records were made per cow. Sixteen percent of the records were less than 10 months duration. There was no indication of breed differences in the number of lifetime 10-month production records per cow. The short lifetime productions of cows have great practical economic significance when one considers that it takes about 2 years to raise heifers to producing age, and they produce only a little over 3 years. (Project 184. Leader: Howard H. Voelker, Dairy Husbandry Dept.)

Growth Studies of Calves and Growing Heifers

Growth trends for dairy cattle under environmental conditions in South Dakota are being determined from birth date through maturity. Heifer calves for the Holsteins, Brown Swiss, Guernseys, and Jerseys in the college herd are weighed at birth and growth measurements are taken as the animals develop through maturity. (Project 153. Leader: Emery Bartle, Dairy Husbandry Dept.)

A Study of the Recovery and Transplantation of the Bovine Ova

Work on this project has primarily been directed toward use of relaxin and its effect upon the cow's cervix. This seems to be the immediate problem if ova transfer is to be made feasible because instruments must be inserted into the cervix. The findings on relaxin at the present time are as follows: (1) 1,500 GPU of relaxin injected into the cow during the estrus period seems to have no effect upon dilation of the cervix during estrus; (2) 1,500 GPU of relaxin dilates the cervix when given with large quantities of diethylstilbestrol. Observations on one cow pretreated over a long period with diethylstilbestrol and then injected with 1,500 GPU of relaxin caused a cervical relaxation equal to that of parturition. In addition, this cow had the appearance of being in labor; (3) three cows were transfused with blood from three donors that were
in labor, with an attempt to determine if relaxin was in the blood in sufficient quantities to relax the cervix of the recipient. Of the three, one showed enough cervical dilation to suggest that there is a factor in the blood capable of relaxing the cervix. In addition this cow had signs of labor. (Project 189. Leader: Arthur E. Dracy, Dairy Husbandry Dept.)

**Improved Pastures for Dairy Cattle**

A study of rotation or continuous grazing for dairy cows showed that grass on the rotation area was more evenly grazed, had fewer weeds, and a more even mixture of alfalfa and brome. Cows grazing on rotation plots produced 16.39% more milk (fat corrected to 4%) per acre, consumed 18.15% more dry matter, and utilized the total digestible nutrients 7.8% more efficiently than cows on continuous pasture. (Project 234. Leader: Emery Battle, Dairy Husbandry Dept.)

**Alfalfa Silage Preservation**

During the past year alfalfa silage was preserved in a bunker with a capacity of 150 tons. Corn and cob meal was added to the wilted silage at 200 pounds per ton in one-third of the silo. The other two-thirds served as control silage. Later the silage was fed with corn and cob meal added at feeding time at rates of 200 and 160 pounds per ton.

Eighteen cows were divided into three groups. One group of cows was fed free choice, alfalfa silage preserved with corn. The other two groups were fed the corn added to the silage as it was fed to obtain an estimate of the corn recovery for milk production. The 12-week feeding trial was divided into three periods so that each cow received each ration.

There was no significant difference in the daily consumption of silage as to time of corn additions. Body weights and milk production results did not indicate significant differences between the groups of cows. The average daily production of 4% milk equivalent for the respective groups was as follows: alfalfa silage, corn preserved, 25.7 lbs.; alfalfa silage, 10% corn added as fed, 26.9 lbs.; alfalfa silage, 8% corn added as fed, 25.3 lbs. This production occurred during the latter part of the cows' lactations. (Project 227. Leader: Howard H. Voelker, Dairy Husbandry Dept.)

**Bloat in Ruminants**

_Dairy:_ Sheep drenched with alfalfa juice equal to 9% of their body weight bloated 31% of the time. Sheep drenched with 9% of their body weight with alfalfa juice plus being injected with 1 grain of atropine, bloated 59% of the time. An equal quantity of 1% glucose solution did not produce bloat at any time, even when given with 1 grain of atropine. Brome grass juices likewise did not produce bloat.

_Animal Husbandry:_ Sheep fed rations high in roughage and concentrates, noted by others to produce bloat, failed to show any evidence of bloat over a 6-month period. The same rations were fed to cattle for 60 days without bloat. Blood, urinary sugar, urinary ketone, and nitrogen fluctuated within normal values with either high roughage or high concentrate rations.

_Bacteriology:_ Approximately 30 separate organisms were isolated from active bloat cases. Some gas producing organisms were selected from the rumen fluid of normal sheep. Sheep drenched daily with 200 ml. of the suspension of rumen organisms showed appearance of bloat.

_Station Biochemistry:_ Studies on methods for assaying plants for their saponin were made. A quick and simple method has been developed and is being used in testing various strains of alfalfa. (Project 245. Leaders: Arthur...
E. Dracy, Dairy Husbandry Dept.; M. W. Adams, Agronomy Dept.; Lawrence Embry, Animal Husbandry Dept.; V. Wallace, Station Biochemistry Dept.; and E. C. Berry, Bacteriology Dept.)

Effects of Administration of Diethylstilbestrol on Young Dairy Cattle

Three groups of male dairy calves (Holsteins and Guernseys, ten calves per group) were used to determine the effects of implanting diethylstilbestrol at 15 and 30 milligrams per calf per month. The calves were implanted at 5 days of age initially, carried on experiment to 88 days, when some were castrated, and then continued to 116 days. The calves were fed concentrates and alfalfa hay free choice and milk according to body weights.

The diethylstilbestrol implants did not induce stimulation of weight gains, increase body measurements, or increase feed consumption or its efficiency of utilization. The implanted stilbestrol pellets did result in reduced testicular development to about one half normal size as had been noted in previous tests with oral administration of diethylstilbestrol. Previous oral administrations of diethylstilbestrol on the same feeding regimen as on implantations resulted in no significant effects on body gains, measurements, feed consumption, or utilization of feed by the calves. (Project 274. Leader: Howard H. Voelker, Dairy Husbandry Dept.)

Also see:
Consumers Preferences, Demand, and Potential Supply for Butter of Various Flavors and Qualities, page 23
Economic Feasibility of Marketing Butterfat as Whole Milk instead of Cream in South Dakota, page 25

Economics Projects

Farm Economics

Determination of Available Surplus Wheat, Rye, and Flax Straw in South Dakota for Industrial Utilization

The purpose of this study was to determine whether any sites in South Dakota had the necessary raw material requirements for a straw pulping plant.

Research indicates there are several promising sites for such a plant. The data gathered could be used by the appropriate agencies to present to paper manufacturers to show the advantages South Dakota has as a future plant site.

Publication: South Dakota Sites for Straw Pulping Plants by R. L. Kristjanson and Winston Ullman, South Dakota Agricultural Experiment Station Bulletin 461. (Project 290. Leaders: R. L. Kristjanson and Winston Ullman, Economics Dept.)

The Evaluation of Pricing and Trading Practices in Local Grain Markets in South Dakota

A recent study showed that, in general, the number of buyers competing...
for grain in any local market area in the state was small. This in no way means that competition does not exist but suggests that competition may take quite a different form from what it would be if there were many buyers, each of whom had only a small part of the market. The type of market structure may be expected to have a significant effect on the form which competition for available grain supplies takes.

A study of the structure of local grain markets and the form which competition for grain takes is being conducted. A survey of 87 elevators has been completed and the data are being tabulated and analyzed.

Information on pricing and trading practices of grain buyers and how they are used in competing for available supplies will be of value to farmers in obtaining maximum returns for their grain. Evaluation of these practices as to cost and effectiveness from the standpoint of grain buyers will be important in increasing marketing efficiency. (Project 299. Leaders: Richard H. Kruse and R. L. Kristjanson, Economics Dept.)

An Analysis of Change in Patterns of Livestock Marketing in South Dakota

The purpose of this study is to determine the changes since 1940 in the types of markets farmers use, why farmers market different species of livestock as they do, what market news farmers use and want, and what changes may be needed in improving the livestock marketing system.

A survey of 450 livestock farmers and ranchers in South Dakota has been completed. These farmers were asked to provide information as to the amount and type of livestock bought and sold in each transaction in 1956. Information was also obtained on factors influencing the farmers' selection of the various channels, markets, and the time of marketing.

During the next year information will be obtained from a representative sample of marketing agencies on sources and disposition of livestock handled and methods and procedures followed in buying and selling. (Project 294. Leader: Anthony L. Pavlick, Economics Dept.)

Consumer Preference, Demand, and Potential Supply for Butter of Various Flavors and Qualities

The purpose of this study is to attempt to get adjustments in the marketing channels for butter so that the butter marketed by South Dakota creameries will be the type of butter desired by consumers.

The first phase of the study dealing with establishing what types of butter consumers prefer has been completed. Based on the analysis of the data from the first phase, a second phase dealing with consumer acceptance of cultured butter has been initiated.

The results of these studies should enable South Dakota creameries to produce and market a higher quality product more acceptable to consumers.


Basis of Country-Point Egg Pricing Policies and Practices and Their Relation to the Nature of Dealers' Operations

In order to obtain information on country egg dealers' pricing policies and
practices, more than 170 licensed dealers in eastern South Dakota were interviewed during the past year. Information pertaining to dealers' volume, procurement areas, disposition of sales, market news sources, and handling and storage facilities, was obtained. The data collected are being studied to determine their relationship to egg dealers' operations.

The study will reveal the extent to which terminal market price quotations are being used by country egg dealers as well as the importance of other factors in determining prices paid farmers. Possibilities for improvements in the marketing channels which will increase returns to producers may be found. (Project 271. Leaders: Gerald Marousek, Economics Dept., and Wm. Kohlmeier, Poultry Dept.)

Wheat Price and Income Policy—Sub-Project No. 1, Supply Response

Wheat is a major South Dakota crop. When wheat prices fluctuate, or when wheat production varies from year to year, the incomes of South Dakota farmers vary tremendously.

Field studies were completed and summaries were made on the production responses of farmers to hypothetical price changes and acreage allotments. (Project 263. Leaders: Philip W. Van Vlack and Richard Kruse, Economics Dept.)

Wheat Price and Income Policy—Sub-Project No. 2, Obstacles to Soil Bank Participation

Wheat production, and thus wheat prices and the incomes of wheat farmers, are supposed to be affected by the Soil Bank program. Nevertheless, many wheat farmers felt they could not sign up for the Acreage Reserve.

Field studies were made to find out specific reasons why wheat farmers did, or did not, participate in Acreage Reserve.

Farmers were also interviewed to find out what they considered were the major economic-ethical issues in the working of the Soil Bank. Similar studies were made of the views of policy makers and program administrators. (Project 263. Leaders: Philip W. Van Vlack and Allan Severson, Economics Dept.)

Improving the Marketing of Farm Supplies in South Dakota with Special Reference to Farm Machinery

A survey was conducted of retail farm equipment dealers in South Dakota. Data on the methods of handling machinery were gathered, as well as information on specific problems of management, taxation, and credit. An article, "Retailing Farm Equipment," was published in the 1956 winter issue of South Dakota Farm and Home Research, Vol. VII, No. 2, pages 57-60.

Conclusions:

(1) In 1955 there were 640 farm machinery dealers in South Dakota. a. This is an expansion over the World War II period.
   b. This number is now reducing.

(2) A limiting factor for success seems to be the number of farms per dealer.

(3) Post war expansion in dealer numbers has gone to the point where dealers in some areas are no longer able to maintain a break even level of income.

(4) Dealer problems include:
   a. Credits.
   b. Dealer laxity in business budgets.
   c. Lack of uniform interpretation of tax laws.
   d. Scalper dealers (who provide no service).

This study should provide information to dealers that will enable them to make more adequate management decisions and hence lower the cost of retail-
ing farm machinery. (Project 266. Leaders: R. L. Kristjanson, C. J. Fliginger, and Winston Ullman, Economics Dept.)

The Best Time to Sell Livestock

Seasonal and cyclical price patterns exist and adjustments to them represent definite and vital problems to farmers and ranchers. Findings to date are of current usefulness only.

An analysis of the problem indicates that when significant amounts of livestock production are shifted to adjust to seasonal or cyclic price patterns, the price pattern shifts or levels out. Seasonal price patterns usually result from some predominant physical or economic production factor such as grazing period, shelter, or housing limits.

Because of these physical limits or seasonal economics of production, price alone is not the only indicator of the best time to sell livestock. Because each farmer or rancher is confronted with a different production situation, the best time to sell for one is not necessarily the best time for all others. (Project 226. Leader: Winston Ullman, Economics Dept.)

Grain Marketing Practices and Problems in South Dakota

Wheat, corn, oats, barley, rye, flaxseed, and soybeans are the principal grains produced in South Dakota. Data from the U. S. Department of Agriculture show that for the period 1950-54, 87% of the wheat, 32% of the corn, 32% of the oats, 52% of the barley, 94% of the flaxseed, and 87% of the rye produced in South Dakota is sold off the farm. Information was lacking concerning how or where this grain moves.

A survey was made in the spring of 1955 (1) to determine the pattern of grain movements after leaving the farm and (2) to ascertain the mode of transportation used.

Results from this survey indicate that about 80% of the grain is moved by rail with truck transportation accounting for the rest. Minneapolis was the major terminal market, receiving about 40% of the grain, followed closely by Sioux City, which received about 33% of the grain. Omaha and Kansas City were also important markets and some grain was shipped to western states, mostly by truck. The market and mode of transportation used appeared to vary with the type of grain.

This study, when completed, will provide basic information concerning grain movements and provide a basis for improving the efficiency of grain marketing in South Dakota. (Project 224. Leader: Richard H. Kruse, Economics Dept.)

The Economic Feasibility of Marketing Butterfat as Whole Milk Instead of Cream in South Dakota

Research on this study was completed and the project is being closed. The results of this study are applicable to most of the West North Central Region, particularly areas of sparse dairy production. They will help dairy marketing research and extension workers in the region in working with and advising creameries and farmers in shifting from cream to whole milk.

A number of creameries in South Dakota have shifted to whole milk, and many farmers have shifted or are in the process of shifting.


Farm Business Management Data and Practices

Seventy farmers and ranchers kept records of inventories, purchases, sales, crops, feed fed to livestock, and live-
sock raised. Each was visited and assisted at least twice during the year. At the end of the year the records were sent in to be summarized and analyzed.

Data from these records are used to compute measures of earnings and efficiency and to provide basis for farm planning and budgeting. A report of the results of the study is to be published when the analyses have been completed. (Project 264. Leader: Charles Benrud, Economics Dept.)

Improving Rural Taxation and Assessments in South Dakota

During the past year an earlier preliminary report regarding the farmers' share of the tax burden was revised and mimeographed as *Taxation in South Dakota*, Agricultural Economics Pamphlet 58. A brief digest of this report was printed as *The South Dakota Farmer and His Taxes*, Circular 128. Further work on taxation and assessment is planned for the next year. (Project 262. Leaders: Max Myers and William Railing, Economics Dept.)

Agricultural Economic Trends in South Dakota, 1900-1950 — Subproject, Land Values

Data on farm land sales have been secured from the register of deeds' offices in eight counties of the state. This will bring up to date previously published data for 1941-55 on farm sales. The data will be summarized within the current fiscal year.

This will provide a continuous record of farm land sales within the prospective irrigation area in central South Dakota from before the irrigation project was approved through 1956. Three counties outside this irrigation area are being used and comparisons can easily be made of sales activity and prices within the prospective irrigation area and other parts of the state.


Agricultural Economic Trends—Subproject, Farm Mortage Foreclosures

During the year, farm and ranch foreclosure data which have been collected since 1921 were analyzed by economic areas and prepared for publication. These data indicate that the strength of South Dakota's agriculture, as measured by farm mortgage foreclosures, is unusually good. Only 16 farm foreclosures were recorded in 1956. Of course, the present land value permits farmers to sell their land or turn it over to the creditor without mortgage foreclosure proceedings.

In general, considerable adjustment of farms and ranches to the soil and climatic factors of the Great Plains and the relatively low land values suggest that farm mortgage foreclosures may never be as serious as they were between 1920 and 1940.


Improving the Farm Credit Situation in South Dakota

This project is still in the "fieldwork" stage. Questionnaires to be used when interviewing bankers are almost complete. These questionnaires should show what type of borrower is having difficulty and what can be done to improve
the situation. No publications have been made under this project this year. (Project 240. Leader: Allen R. Clark, Economics Dept.)

Farm Tenancy Improvement in South Dakota

The English cash leasing system is generally regarded as the best leasing system in the world. How does it compare with crop share leasing in the Great Plains?

The English leasing cash system has been used in Marion County Kansas since 1870 with little change. This provided a unique opportunity to study the two systems.

A report will be published during the next year. This report indicates that the English cash leasing system provides more security and more freedom of operation. Farming practices were equally as good as on other farms in the community. More conservation work had been done on the cash leased lands.

A manuscript, Improving Farm and Ranch Leasing, also will be published next year. (Project 147. Leader: Russell L. Berry, Economics Dept.)

How Beginning Farm Families Become Established in Farming

Records of all land in Spink County which had a different operator in 1956 than in 1955 were obtained. From this information, which is now being coded on IBM cards, the quantity of land going to established farmers who are expanding their farming operations will be determined. In addition, data on the quantity of land released by those retiring from the farm or decreasing the size of their farm will be available. The difference between these two, the acres released by farmers giving up some or all of their land and the acres acquired by those expanding the size of their farm, will be the remainder which is available to beginning farmers. The quantity of land available to beginning farmers, however, is not a true measure of their opportunities to become established farmers. Other factors are: actual farm size, fertility of the land, credit, and tenure arrangement. All beginning farmers in Spink County, plus a sample of established operators who were competing for land in 1956, were interviewed to gain some insight into the problems a beginning farmer encounters in acquiring sufficient good land and credit and a satisfactory tenure arrangement to enable him to become securely established in farming. This information is now being analyzed for future publication. (Project 166. Leaders: Loyd Glover and Gordon Ferguson, Economics Dept.)

Weather Information for Agriculture

South Dakota weather data for 70 Weather Bureau Stations through the calendar year 1955 have been placed on IBM punch cards. Some of these data have been published in Weather Bureau publications but the data have not been well organized for use in individual research work.

Data for 60 stations have been summarized on a weekly basis from the start of continuous data for each station through the calendar year 1955 to provide information adaptable to current research projects.

Several mimeograph pamphlets have been published during the fiscal year 1956-57.

These are Agricultural Economics Pamphlets:

71—Weekly Summary of Climatological Data, Faulkton, South Dakota, 1900-1953.
78—Yearly Dates of Last Spring and First Fall Occurrence of Minimum Temperature of 24° F. or Lower for 58 Weather Bureau Stations of South Dakota.
79—Yearly Dates of Last Spring and First Fall Occurrence of Minimum Temperature of 28° F. or Lower for 58
Weather Bureau Stations of South Dakota.
80—Yearly Dates of Last Spring and First Fall Occurrence of Minimum Temperature of 32° F. or lower for 58 Weather Bureau Stations of South Dakota.

83—Frequencies of Daily Occurrence of Maximum and Minimum Temperatures at Huron, South Dakota Each Week of the Year by Five Degree Intervals Together with Highest and Lowest Temperature Recorded and Standard Deviation of Temperatures Each Week of the Year.

84—Graphic Presentation of Weekly Mean Maximum and Mean Minimum Temperatures for South Dakota Weather Stations for Each Week of the Year. (Project 291. Leaders: Max Myers and Ray Pengra, Economics Dept.)

Improving Arrangements for Organizing and Financing Small Watershed Projects

In order to cooperate with federal agencies in the development of water management projects in small watersheds, local groups must be able to organize in a way to enable them to carry out certain responsibilities. Local groups usually are asked to furnish easements, rights-of-way, water rights, and maintenance.

To carry out these responsibilities, technical assistance is needed in organizing properly, educational programs, and preparation of financial plans. A technique for computing equitable special benefit assessments under a Watershed Protection and Flood Prevention project has been developed and appears in the Masters Thesis of Henry Ziegler, July 1957. Further work in financial planning for local improvement projects is being carried on and a publication of the results is anticipated for the coming year. (Project 301. Leader: Loyd Glover, Economics Dept.)

Economics of Soil Conservation

Wheat production is exceeding the demand at prices which farmers are willing to accept. As a result marketing quotas and acreage allotments are being used to control production. What are the possibilities of shifting from wheat to grasses and legumes? To what extent have farmers shifted to legumes and grasses in the southeastern part of South Dakota?

These two questions are being investigated with the cooperation of ARS, USDA. (Project 211. Leader: Russell L. Berry, Economics Dept.)

Economics of Irrigation

What will irrigation and other farm programs do to farm incomes? How much can farmers afford to pay for water? To answer these and many other such questions, farm prices and costs have been prepared for farm planning and budgeting and will be published in mimeographed form during the next fiscal year. These prices will be used by the Station and the Bureau of Reclamation in the study of the feasibility of irrigation. (Project 198. Leader: Russell L. Berry, Economics Dept.)

Also see:
Reducing Farm to Market Losses, page 16
Marketing Roughages, page 16
The Development and Analysis of Improved Techniques for Marketing Poultry Products, page 43
Investigations of the Corn Rootworm Complex (*Diabrotica* spp.) in South Dakota, Their Economic Importance, Life Histories, and Control

In test fields, observations in percentages of species emerging indicated 5% *Diabrotica virgifera* (western), 0.1% *D. undecimpunctata* (southern), and 94.9% *D. longicornis* (northern). Emergence took place over a period of 40 days, beginning the latter part of July. There were no indications of rootworms feeding on roots of sorghum. The average number of larvae feeding on corn roots was 0.5 per stalk with the highest number observed being 8. Yields in untreated plots were not materially reduced below that of the insecticide treated plots.

Test plots for the current growing season (1957) were insecticide treated just prior to heavy flooding which will quite likely ruin the insecticide tests for this year. (Project 247. Leader: Gerald B. Spawn, Entomology-Zoology Dept.)

The European Corn Borer in South Dakota—Its Control, Life History, and Distribution

Drought conditions and consequent serious reduction in yield of corn made the corn borer an almost negligible factor in corn production for southeastern South Dakota in 1956. Granulated insecticides and sprays were applied but with results which could not be considered indicative of their value.

The corn borer population, in the fall of 1956, was down to approximately one-third of the previous year's numbers in the southeast. Spring studies indicated a rather high winter survival of borers; however, weather conditions in the spring of 1957 have not been favorable to the borer. Damage by first brood borers will likely be limited to only those corn fields where development of the plants is most advanced.

Studies indicate that two introduced species of corn borer parasites, *Lydella*, a fly, and *Horogenes*, a wasp, have become established in South Dakota. (Project 187. Leader: Gerald B. Spawn, Entomology-Zoology Dept.)

Investigations of the Alfalfa Insect Situation in South Dakota

In the replicated tests of insecticide treatments for second cutting alfalfa seed production, 20 different applications were made. The best yields were obtained with DDT and Toxaphene applied at the 6-inch growth stage and again at the bud stage. Drouth severely reduced yields in all tests.

Non-replicated field tests of different insecticides in 15-acre plots applied only at the bud stage showed DDT and Toxaphene again to give the best results.

The control of the alfalfa weevil with granulated forms of insecticides proved to be very effective. Dieldrin or Heptachlor applied at one-fourth pound actual insecticide in March or twice that amount in December equalled the control provided by sprays applied to early foliage.

Of 51 varieties and lines of alfalfa tested for resistance to the spotted alfalfa aphid, only Ranger (60% resist-
ant) as a northern adapted variety showed promise of commercial desirability. (Project 288. Leader: R. J. Walstrom, Entomology-Zoology Dept.)

The Control, Economics, and Biology of Certain Insects, Mites, and Ticks Affecting Cattle, Sheep, and Swine

Much work prior to the fiscal year 1956 was continued last year. Fly control studies (summarized in Bulletin 452, May 1955) have narrowed to exploratory work on the control of stable flies. In this connection residual insecticides, repellents, and larvicides were investigated.

A geographical study of housefly resistance to insecticides (begun in 1954) is being prepared for publication. This study revealed no DDT susceptibility and a uniform response to lindane that implied a low level of resistance, as compared to DDT, of houseflies to lindane. No evidence of Diazinon resistance was found. (Project 186. Leader Wm. M. Rogoff, Entomology-Zoology Dept.)

Investigations to Develop a Systemic, Chemotherapeutic Method of Controlling Cattle Grubs

This project has been pursued along three major lines in the fiscal year 1956: laboratory studies, yard tests with cattle, and field tests using cooperators' herds. The laboratory work has included mode-of-action studies of promising materials, and the screening of approximately 65 candidate compounds for materials toxic to oesophageal stage grubs.

Cattle used in the yard tests numbered 43 head, allotted by weight into eight groups. Different groups were treated with candidate systemic agents administered as single oral doses, daily low-level feeding of individual animals, free-choice salt, and external washing of individual animals.

Field tests involved administering a single oral drench of ET-57 to half the animals in two cooperators' herds, the other animals serving as controls. These tests included a total of 165 head of cattle.

Work on this project has been closely integrated with similar work in other parts of the country. (Project 244. Leaders: Wm. M. Rogoff, Entomology Zoology Dept.; Paul H. Kohler and Robert Duxbury, Animal Husbandry Dept.)

The Fringed Tapeworm of Sheep in South Dakota

Through the cooperation of Morrell's and Armour's packing plants and sheep buyers and feeders, some heavily infected lots of sheep have been traced to their home ranges. These ranges have been checked for invertebrates which might possibly serve as vectors of the fringed tapeworm. Small predaceous mites found in sheep dung have been under suspicion. Some mites have been fed tapeworm eggs experimentally, but efforts to maintain the mites alive for long periods have failed.

Through the cooperation of the State Big Game Biologist, a number of antelope livers have been checked for presence of the fringed tapeworm, but all have been negative so far. (Project 260. Leader: E. J. Huggins, Entomology-Zoology Dept.)

Fish Parasites in South Dakota

A number of fishes from South Dakota lakes were examined for parasites during the past year. As in previous years, a host record sheet was kept for each fish with such data as name and size of fish, source, date taken, and number, kinds, and location of parasites found. The parasites were preserved, and some were stained and mounted on permanent slides.

The findings of this project are being prepared for publication in the form of a bulletin in the near future. (Project 277. Leader: E. J. Huggins, Entomology Zoology Dept.)
Intestinal Parasites of Cattle, Their Control, and Their Effect on Rate of Gain

Calves at Eureka and at Cottonwood were divided into two groups at each station, one group to serve as controls and the other to receive micronized phenothiazine in capsules once in the fall and again in the spring. Fecal samples from all animals were collected at intervals, and quantitative and qualitative examinations were made for worm eggs.

Many of the calves appeared to be rather heavily parasitized. The phenothiazine seems to have had little effect. This may be explained by the fact that most of the eggs identified have been from a tapeworm, Moniezia benedeni, and two genera of roundworms, Nematodirus and Strongyloides, which are relatively unaffected by phenothiazine. Although the drug has been found to be the best all-around anthelminthic for roundworms in many parts of the country, it may turn out that South Dakota cattle are most heavily parasitized by the few species against which the drug is ineffective. Further studies are needed before a recommendation can be made concerning the use of phenothiazine for cattle in South Dakota. (Project 278. Leader: E. J. Huggins. Entomology-Zoology Dept.)

Strains of Trees and Shrubs of South Dakota Farms and the Control of the Insects and Diseases that Attack Them

The Bronze Birch Borer, Agrilus anxius Gory, plus drought, has killed the majority of birch trees in eastern South Dakota during the past five years. The insect pest passes through four distinct stages in completing its life cycle—the beetle stage, the egg, the larval, grub or borer stage, and the pupa. The winter is passed in the grub stage under the bark of the host tree. Pupation takes place in the spring under the bark and adults are present during the latter part of June and during July in the Brookings area. Egg-laying takes place during the time the adults or beetles are present. The adults feed on the leaves of birch and poplar; but the largest amount of damage is done by the larvae. These bore underneath the bark of the trees, where they eat out tunnels. The tunnels may entirely girdle the trunk or limbs and should this occur, the infested trunk or limb dies. Many of the borers are able to complete their entire life cycle in one year, but others may require two years.

DDT (50% wettable) applied to the tree at the rate of 1 or 2 pounds per 100 gallons of water is a satisfactory control of this pest. The DDT spray should be applied liberally to the trunk, limbs, twigs, and leaves. Two applications should be made to each tree, the first about June 10 in the Brookings area and the second about 3 weeks later. In the southern part of the state, the first application should be made about June 1, while in the northern part the first spray should be applied about June 25. A second spray should be applied to the tree in each area 3 weeks later. (Project 142. Leader: H. C. Severin, Entomology-Zoology Dept.)

Emergency Outbreaks of Insects and Their Control

Lygus Complex: The Lygus bugs are leaf bugs belonging to the family Miridae. The species of Lygus constitute an exceedingly difficult taxonomic complex. The species that occur in South Dakota must be determined, their life cycles and seasonal cycles must be studied, their food plants must be determined, and the economic importance of each species must be learned. Some species of Lygus affect the alfalfa and clover seed producer, some affect the growers of fruits, and some the grower of vegetables. Control of the economic species must be worked out.

Through investigations carried on
thus far, about 20 species of *Lygus* have been taken in South Dakota. Some of these species are of considerable economic importance, while others are of little or no economic importance. Some species seem to be limited to a wide variety of food plants, while others are just the opposite. Some pass the winter as adults, while others do so in the egg stage.

While fairly good controls of species of *Lygus* affecting alfalfa and sweet clover seed production are well known and practiced in South Dakota, much pertinent information is lacking concerning the species of *Lygus* in which the grower of alfalfa and sweet clover seed is interested. Very little is known about the species of *Lygus* that affect the fruit and vegetable grower in South Dakota.

**Screw-worm and Secondary Maggots:**
Six samples of secondary maggots were received from farmers, county agents, or veterinarians during the past year. These were identified and the persons concerned were notified regarding the control and eradication of the pests. No true screw-worms were submitted to us during the year.

This project should be continued for one cannot predict when true screw-worms may make their way into South Dakota. Should this occur, it is highly important that the screw-worms be discovered as quickly as possible after their introduction, in order that the pest may be eradicated before it has the opportunity to multiply and spread and do considerable damage.

**Tree-hoppers or Membracidae of South Dakota:** This project is nearly completed. Sixty-five species of tree-hoppers have been taken in South Dakota thus far. Of these, the Buffalo Tree-hopper, *Sictocephala bubalis* (F) and the Flat-footed Tree-hopper *Camptylechita latipes* (Say) are the most harmful species. The Buffalo Tree-hopper was treated in an article appearing in Farm and Home Research, Vol. VII, No. 3, 1956, pp. 64-65. The Flat-footed Tree-hopper is important economically principally because it feeds on alfalfa.

**Lady Beetles or Coccinellidae of South Dakota:** This project is nearly completed. About 60 species and varieties of lady beetles have been taken in South Dakota thus far. All of these with one exception are considered to be beneficial to mankind, because the adult beetles as well as the larval stages feed largely on plant lice or aphids, scale insects, and other small harmful insect and mite pests. They may also feed on the eggs of some of our larger insects and upon pollen of plants. The only harmful species of lady beetle that occurs in South Dakota is the Mexican Bean Beetle, *Epilachna varivestris*, Mulsant. This species occurs at the present time in western South Dakota and feeds on the leaves of beans. (Project 220. Leader: H. C. Severin, Entomology-Zoology Dept.)

Shelterbelts add beauty and comfort to the farmstead. Studies are conducted here to determine the best trees and planting arrangements for your shelterbelt.
The Differences Among Wool Suitings and Those Made Wholly or in Part of Chemically Manufactured Fibers with Respect to Certain Properties

Studies of suitings of a variety of fibers blended with wool have been underway for some time. From the findings thus far it is apparent that wool and the chemically manufactured fibers may complement each other and in general 50% or more of the synthetic fibers may be required before an effective benefit of their advantage can be realized. (Project 215. Leader: Lillian Lund, Home Economics Dept., in cooperation with Suzanne Davison, Minnesota Agricultural Experiment Station.)

Comparative Serviceability of Shirting and Blouse Fabrics Made of Synthetic Fibers, Cotton, or Other Natural Fibers

Several fabrics suitable for blouses and shirts were used in a laboratory study. Data on physical measurements have been collected and are being analyzed statistically and prepared for use in a publication. (Project 254. Leader: Lillian Lund, Home Economics Dept., in cooperation with Suzanne Davison, Minnesota Agricultural Experiment Station.)

Measure of Serviceability for Fabrics and Garments

Boys' blue jeans which were worn last year were cut up and laboratory determinations on physical properties were made. The results have been summarized and the statistical analysis and interpretation of data are in progress. (Project 259. Leader: Lillian Lund, Home Economics Dept., in cooperation with Suzanne Davison, Minnesota Agricultural Experiment Station.)

A Study in the Nutritive Value and Use of South Dakota Grown Fruits and Vegetables

Analysis of ten varieties of Sand Cherries for ascorbic acid showed few differences from the earlier study. The culinary quality was evaluated by preparing a cobbler from each variety. These were scored by as many staff members as were available. Some of the varieties tested were new ones developed by the Horticulture Department; others had been tested previously.

Of the named varieties, Chekka rated the highest being scored Excellent by one-half the judges and Good by one-third. Oahe, Wampum, Tepee, and Amber also had high ratings. Ruby rated highest in color, although its overall rating was slightly lower than the others.

Chekka, Wampum, and Oahe were easy to pit. Ruby and Amber were best for eating raw.

It is planned that this project will be concluded in 1958 with publication of the results of the studies on asparagus. (Project 210. Leader: Lida Burrill, Home Economics Dept.)

Nutritional Status and Dietary Needs of Population Groups in South Dakota

Much time has been spent on the analysis of data collected earlier on the utilization of protein by older women.
The new bomb Calorimeter was used to determine the energy value of the meals eaten. Calcium and phosphorus balances have been completed on the three subjects.

A method for the evaluation of protein nutriture developed at the Iowa Experiment Station has been applied to three South Dakota subjects. However, the full significance of this evaluation is yet to be determined.

**Horticulture Projects**

**Fruits, Vegetables, and Shelterbelts**

**Vegetative Propagation of Hardy Ornamental Plants**

Various types of softwood cuttings of the rose Lillian Gibson were taken during the spring of 1957 and rooted under mist in a specially constructed propagating house. To date fair success has been obtained, but evaluations of the various techniques are being continued to ascertain the methods which give the greatest percentage of good plants. Rooted cuttings are being field planted to increase the stock and also to find if there are problems in getting these small plants adjusted to outdoor conditions. (Project 258. Leader: Jesse M. Rawson, Horticultural Dept.)

**New Methods of Constructing and Heating Small Greenhouses in South Dakota**

Additional work since being reported in Farm and Home Research, Spring 1956, includes the addition of an improved thermostat control, a ventilating fan, inexpensive benches, and improved temperature alarm system. Plants were successfully grown on benches and directly in ground beds. During the winter, however, growth was slow in ground beds because of low soil temperatures. However, in late winter growth accelerated and provided high quality early spring flowers and vegetables. (Project 286. Leader: Jesse M. Rawson, Horticultural Dept.)

**The Effect of Spacing on the Survival, Growth, and Effectiveness of Windbreaks and Shelterbelts in South Dakota**

The 1954 test planting at the Brookings Station and the 1955 planting at the Highmore Substation were provided the necessary maintenance to control weeds. Plantings were made to replace the previous year's losses.

Siberian elm in the 8-foot between-row spacing treatment is nearing com-

**Also see:**

Maintaining Quality of Turkey Meat in Market Channels, page 45
Farm and Home Water Quality, page 48
plete crown closure indicating that weed control in these rows will very shortly be accomplished by the trees themselves. Wider between-row spacings will require several more years of cultivation. (Project 239. Leader: Paul E. Collins, Horticultural Dept.)

Selection of Adapted Species and Strains of Trees and Shrubs for South Dakota Farms

Conifer transplants originating from seed collected in various geographical regions were planted out in permanent test plots. The planting will test the adaptability of strains of ponderosa, red, white, jack, lodgepole, limber, Austrian, and Scotch pines; Douglas and white fir; and white, Black Hills, blue, Norway, and Engelmann spruces.

Elm pollen obtained from several Arboretums and other sources was used in hybridization studies. Crosses were made on cut branches and bottle grafts of Siberian, American, slippery, and European white elms. Difficulty in carrying the branches to fruiting limited the effectiveness of the study.

Maintenance and observation were continued on permanent test plots planted in prior years. (Project 142. Leader: Paul E. Collins, Horticultural Dept.)

Growth and Yield of Strawberries and Raspberries as Influenced by Cultural Treatment

The use of crushed corn cobs as a mulch for strawberries in the summer of 1956 resulted in better plant growth, greater weed control, and reduced soil packing between the rows. Crushed cobs appeared to be more desirable than the grass mulch with which they were compared. They give little protection as a winter cover, but are excellent as a summer mulch. Senator Dunlap and Premier, two old varieties, continue to compare favorably with other varieties.

Red raspberry plants survive the winter much better when the plants are thoroughly provided with ample water during the growing season. Less winter injury has resulted to the Latham variety when the canes were bent over and covered with soil. Only slightly greater loss resulted when plants were irrigated. Winter killing increased when plants were fertilized with nitrogen in early July. (Project 145. Leader: S. A. McCrory, Horticultural Dept.)

The Collecting, Preserving, Cataloging, Propagating, and Testing of Fruit Plants Having Potential Genetic Value

The fruit plants in this study were collected from foreign and domestic sources where climatic conditions had eliminated all but the winter hardy. Many of the plants in this collection have reached a bearing age. A good crop in 1956 has made possible better evaluation. Characteristics, such as the color of fruit, size, ripening date, and fruiting habits, that fruit breeders might desire were noted. Observations were more to determine genetic value than fruit quality.

Because of the winter hardiness of the material, it is being used in breeding work in many areas. Of particular interest has been some of the root stocks. It is too early to tell how many of these plants have value or to what extent they may be used. A descriptive report is being prepared which may help in finding uses for this material. (Project 174. Leader: S. A. McCrory, Horticultural Dept.)

Production and Breeding of Early Drought and Disease Resistant, High Quality Tomatoes for Home Use

From a breeding population grown in the summer of 1956, 33 tomato selections were made. The primary basis for selection was early fruiting; however, other characters such as fruit size and quality, plant type, and disease toler-
ance were considered. During the winter, further crosses were made between varieties thought to have additional desirable breeding characters. (Project 49. Leader: R. L. Nickeson, Horticultural Dept.)

Modification of Wind and Temperature to Improve Vegetable Yields and Quality

No progress was made on this project during the past year as the position of leader was vacant. (Project 118. Leader: R. L. Nickeson, Horticultural Dept.)

Breeding Tree Fruits for South Dakota

Continued progress was made in hybridizing high quality varieties of apples, pears, and apricots with hardy adapted varieties. Approximately 3,000 new apple seedlings were germinated and are now growing in ground beds in the greenhouse, 1,000 pears were started in pots and later transplanted to the orchard, and a small number of apricot hybrids were grown in pots for later transplanting to the field. These apricots will serve as a basic core for future breeding. In addition, many varieties of the different tree fruits were planted in the orchard for evaluation and for breeding purposes. Some of these offer promise as outstanding breeding material. Evaluation of older seedling trees was continued. Particular attention was given to such characters as annual bearing, quality, attractiveness, and the ability of the fruit to hang well on the tree.


Breeding Small Fruits for South Dakota

A large number of seedlings resulting from hybridizing high quality grape varieties with hardy native grapes were started in the greenhouse and later transplanted to the nursery. These, together with similar hybrids growing in the field, will serve as a core for future breeding.

A large field of black raspberry seedlings was evaluated for winter hardiness. The canes were purposely exposed to severe winter conditions by tying them to upright stakes. The more hardy plants will be further evaluated for hardiness and then the best ones will be used in breeding. Several native red raspberry seedlings are also being evaluated for hardiness.


Researchers use precision equipment in studies.
Plant Pathology Projects

Plant Diseases

Potato Disease Control Investigation

Scab control has been investigated along two major lines—resistance, and through the application of soil fungicides. About 30 lines of potatoes, selected from previous experiments, were grown in randomized block with four replications.

In general, those with the most resistance to scab failed to yield well.

The application of Terraclor, a new fungicide, at 5, 10, 15, and 20 pounds per acre, effectively controlled scab at the 20 pound per acre dosage. This material appears promising as a simple control to a disease that is a serious problem each season in the potato growing areas of the state. (Project 107. Leaders: H. G. Pulsifer and C. M. Nagel, Plant Pathology Dept.)

The Biology and Control of Forage Grass Diseases

Approximately 200 selections grown in the brome grass breeding nursery were rated for resistance to Helminthosporium bromi. Additional new selections were screened and rated for Helminthosporium resistance in the greenhouse. Collections and isolations were made of Helminthosporium from various grass hosts and these were used to inoculate several cultivated forage grasses. All the grasses were susceptible to some of the isolates and it was found that many of the isolates infected brome grass and produced symptoms similar to H. bromi. In the field these spots could easily be included in ratings for H. bromi which lead to inaccurate evaluation of resistance.

In testing selections of crested wheat grass for resistance to Pythium seedling blight, isolates of Pythium were made from corn, oats, and crested wheat grass. Most of the corn isolates severely reduced the stand of crested wheat grass. Isolates from oats were almost non-pathogenic and those from crested wheat grass were intermediate. The selections under study differed in their resistance to isolates from all hosts. One selection, however, showed good resistance to most Pythium isolates from all hosts. In order to retain all selections with resistance, it appears that Pythium isolates of intermediate virulence are most suitable for initial screening of crested wheat grass selections to be used for breeding. (Project 250. Leader: C. J. Mankin, Plant Pathology Dept.)

The Nature and Control of Certain Soil Borne Diseases of Sorghum

Early, mid, and late season plantings of sorghum treated with 11 different fungicides were planted at Brookings and Highmore. At Brookings all fungicides improved the stands of the first two plantings, but at Highmore six of the materials failed to significantly increase stands. None of the new experimental fungicides improved stands over the commonly available materials.

Many factors, alone or through interactions, appear to depress sorghum stands. It has been shown in the laboratory that combinations of temperature
and moisture affect sorghum emergence in different ways. At low temperatures stands are reduced as moisture increases, but at high temperatures stands are reduced as moisture decreases.

In the field the best sorghum stands have been obtained with treated seed planted at the second date of planting. Usually, at this time the interaction between good moisture and favorable temperature promotes rapid germination, and because pathogenicity is low, seedling emergence is relatively good.

Soil fumigation was used in an attempt to more accurately evaluate and measure losses due to root rot. Several criteria such as emergence, plant height, time of heading, yield, and the actual amount of root rot on the roots were taken to measure differences between fumigated and non-fumigated plots. No significant differences could be detected in any category. Sorghum lines that differed in root rot development were consistent with previous findings and appear to be genetic. The actual effect of root rot on yield remains unknown. (Project 110. Leader: C. J. Mankin, Plant Pathology Dept.)

Foliage Diseases of Small Grain and Their Control

In experiments dealing with factors affecting build up of wheat stem rust it was found that from an initial natural infection of one pustule per 8 square feet occurring in early June, further development reached 70 to 100% severity by the soft-to-hard dough stage in late July. At least four races were involved: 15B, 56, 29, and 11. About 50 entries from 3,000 entries of the world collection of wheat were selected for further study because of their stem rust resistance.

Loose smut of wheat was collected in 37 fields including winter, spring, and durum types. An average of about 1% infection occurred. By using several of the above mentioned collections loose smut infections were obtained from 121 inoculations on 11 Canadian loose smut differential varieties. Race identification will not be available until complete inoculation results have been obtained. Infection was fair to good in the Uniform Spring Wheat Bunt Nursery grown to evaluate experimental material for bunt resistance.

A survey of barley diseases that are carried in the embryos of seed indicated that about 40% of 29 samples examined carried at least a trace of barley stripe-mosaic. The average infection was 0.83%, and the highest amount of infection in any one sample was 5.9%. About 40% of the samples carried nuda loose smut. The average infection was 1% and the highest 8%.

In experiments on Septoria leaf spot plots had more nitrogen and available phosphorus than the control. The highest yielding varieties in the control plot showed the least response to fumigation, indicating that the response to fumigation would not be a fruitful approach for selecting resistance. (Project 115. Leader: Richard E. Ohms, Plant Pathology Dept.)
of barley it was found that seedling symptoms are expressed better at an average greenhouse temperature of 73° F. than at two lower temperatures. By using 25 entries from the world barley collection it was possible to divide types of symptoms into five groups ranging from no symptoms to severe symptoms.

Eight isolates of Gibberella zeae, a cause of wheat head blight, when inoculated onto heads of seven varieties of spring wheat by a spray method, were shown to differ in virulence ranging from a high of 69% average seed infection to 15%. Varieties also showed a range of susceptibility from 1% to 36% seed infection. (Project 204. Leader: J. F. Hennen, Plant Pathology Dept.)

Oat Diseases and Their Control

Twenty-one oat varieties were compared on chloropicrin treated and non-treated field plots. There was little development of root rot on either plot so the effect of the fumigation in reducing root rot was not clearly established. However, there were considerable increases in general vigor, plant height, and yields of certain varieties on the chloropicrin treated plots. Analysis of soil samples, taken at heading time, showed that the nitrate nitrogen of the chloropicrin treated plot was better than twice that of the non-treated plot. Thus, the increases in heights and yields on the treated plots may have been a straight response to increased nitrogen and be independent of any fumigation effect in controlling root rotting organisms.

Nine chemical seed protectants were tested on Vikota oats for their effectiveness in terms of increased stands. Significant increases in stands were obtained with eight of the chemicals tested with Panogen and Ceresan M being particularly outstanding.

Data were obtained on the stem rust reaction and the reaction to a non-parasitic leaf spot of 764 entries from the oat world collection. A few of the entries were highly resistant to stem rust; however, most of the entries were only moderately resistant to the non-parasitic leaf spot. (Project 283. Leader: L. S. Wood, Plant Pathology Dept.)

Investigations and Control of Alfalfa and Other Forage Legume Diseases

Pseudopeziza jonesii, Ascochyta imperfecta (Phoma herbarum var. medicaginis), and Cercospora sebrina were the principal agents of alfalfa leaf and/or stem diseases at Brookings and other areas in the state during the moderately dry season of 1956, while Pseudopeziza medicaginis and Stemphylium botryosum were only minor agents.

Clones in the breeding nursery at Brookings were again evaluated for disease. Twenty-five fungi isolated from rotting alfalfa crowns failed to reproduce the rot when introduced into the crown of 5-month-old Ranger, Vernal, Ladack, Cossack, and Grimm alfalfa plants lifted from the field and planted in pots in the greenhouse. Rhizoctonia solani, Fusarium spp., and Sclerotium bataticola in the roots and stems; Septoria glycines, Glonaerella glycines, and Cercospora kikuchii chiefly on the stems; and Pseudomonas glycinea, and Xanthomonas phaseoli var. sojense on the leaves were the principal agents causing soybean diseases during the 1956 season. (Project 230. Leader: G. Semeniuk, Plant Pathology Dept.)

Control of Diseases Affecting Shelterbelts, Forest, and Shade Trees in South Dakota

In addition to leaf rust control, there is an important need for the control of cottonwood canker. Canker frequently girdles the bark or main stem of the tree as well as the basal part of the lower branches. Since leaf rust control has been satisfactorily accomplished through resistance in the new strain released a few years ago, namely Siouxland, can-
ker is the most urgent problem from the standpoint of disease control in cotton-woods for shelterbelt and farmstead plantings.

During the past two seasons field results indicate that a strain is being developed which is not only highly resistant to leaf rust but to canker as well. (Project 292. Leader: C. M. Nagel, Plant Pathology Dept.)

Corn Diseases and Their Control

In cooperation with the Brookhaven National Radiation Laboratory, about 20 inbred lines of corn have been exposed to gamma rays. This seed has been planted in the field for observation and ultimate selection. The inbred lines radiated were composed of highly susceptible and disease resistant lines of dent corn to root rot, rust, leaf spot, and stalk rot. The objective was to determine if susceptibility or resistance can be influenced, and, particularly, whether disease resistance can be improved.

In cooperation with Dr. D. B. Shank of the Agronomy Department, 300 selected inbred disease tolerant lines of corn were top crossed to three “tester” lines consisting of single crosses to determine the effect of the disease resistant inbred lines in three-way crosses on root rot, rust, ear rot, and yield.

These three-way hybrids have been planted at the Brookings, Menno, Highmore, and Watertown stations. Two hundred inbred lines were indexed in greenhouse benches for disease resistance during the past winter. Lines promising good resistance to root rot resulted from these experiments. (Project 185. Leader: C. M. Nagel, Plant Pathology Dept.)

The Quality of Grass and Alfalfa Silage as Affected by the Development of Specific Microorganisms

Approximately 500 cultures of thermophilic actinomycetes and fungi capable of growing at 45° or 55° C. have been obtained from the moldy portion of openly stacked alfalfa, corn, and sorghum silage; from heated wheat; and from wheat, oats, and soybeans maintained at 45°, 55°, and 60° C. The same type of microorganisms were obtained from all of these materials. The actinomycetes included species of Streptomyces and Thermoactinomyces while the fungi included Aspergillus fumigatus, Mucor pusillus, Lichtheimia corymbifera, Malbranchea pulchella, Monotospora lanuginosa, and species of Paecilomyces, Penicillium, and Sporotrichum. Most of these microorganisms grew readily on pH neutralized or non-neutralized, sugared or non-sugared agar media supplied with aqueous extracts from the outer alkaline moldy portion of openly stacked alfalfa, but failed to grow or grew poorly on similar media supplied with aqueous extracts from the inner acid, non-moldy portion of such stacks. Two-ton open, cylindrical stacks of alfalfa acidified to pH 3.9 or supplemented with 165 pounds of Car-mo-las heated and spoiled as readily as the untreated stacks, while other similar stacks covered tightly with plastic sheets did not heat and produced fair silage, especially when acidified or supplemented with Car-mo-las. (Project 237. Leader: G. Semeniuk, Plant Pathology Dept.)

Flax Diseases and Their Control

One of the most important disease problems of flax is the control of pasmo. Pasmo is a disease that attacks the leaves, stems, and the floral parts with the resulting decrease in the yield and quality of the crop. The varieties of flax recommended for commercial production are susceptible to pasmo, although the variety Marine is considered somewhat tolerant to this disease.

There are two principal methods possible for the control of pasmo; these are the use of resistant varieties and the application of chemicals as a foliar
Spray. Sources of resistance are being sought in flax varieties collected from all parts of the world. Almost 1,000 samples have been collected from 35 countries of the world. Approximately 100 selections of the world collection were classified as resistant as, or more resistant than, Marine when tested at Brookings and Watertown last summer. These selections are being tested again to determine if the resistance is strictly genetic or if the environment is influencing their reaction to the disease. Approximately 25 of these have been crossed with Marine and Redwing in an attempt to transfer the pasmo resistance to accepted varieties. Additional samples from throughout the world are being collected and they will be tested for their resistance to pasmo.

Different species of flax are being tested as an additional source of resistance. The first step has been to increase seed of approximately 40 different species and varieties in this group. Although crosses of common flax with other species of flax have not been very successful, perhaps techniques other than those previously attempted can be developed for crossing different species of flax if these species are resistant to pasmo.

Seed of three varieties have been irradiated with X-rays and thermal neutrons as another possible source of resistance. It is hoped that mutants more resistant to pasmo than the parent varieties will be found. The X-ray treatment resulted in death of most of the plants, but additional seed has been treated at reduced dosages. Selection of resistant mutants will be made in the summer of 1957.

Control of pasmo with a chemical was partially successful in tests made at Brookings last summer. The rate and number of applications will be determined and additional chemicals are being tested. (Project 276. Leader: M. E. Michaelson, Plant Pathology Dept.)

Seed Treatment and Soil Amendments for the Control of Seed Rot and Seedling Blight

Twenty seed treatment fungicides were applied to dent corn and planted in field experiments. Seed of South Dakota hybrids 250 and 270 were used in these experiments. Two row plots, ten hills long, were replicated four times for each treatment. Ideal growing conditions at planting time produced stands which were not significantly different.

Chloropicrin was used as a soil fumigant to control soil-borne diseases of corn. Vegetative growth of corn plants on treated soil was one-third greater at start of tasseling.

Various seed treatments were used to control rhizoctonia blight of flax, including certain of the chemicals applied as a soil drench; however, no significant differences in control were obtained. (Project 296. Leaders: C. M. Nagel and V. D. Pederson, Plant Pathology Dept.)

New crop varieties are grown and studied under field conditions before being released for increase.
Poultry and Bacteriology Projects

Poultry Production

The Control of Selenium Poisoning in Poultry

An extensive 4-week growth experiment with chicks has confirmed earlier work that with levels of selenium at 10 ppm, the combination of dl-methionine and glycocyamine partially overcame the toxic effects of selenium. The more severe toxicity obtained with selenium at 15 ppm, was not affected by glycocyamine and methionine additions to the diet. This may indicate a basic difference in the mode of selenium toxicity under chronic or acute conditions.

Further work has shown that methionine can be replaced by betaine or choline in overcoming selenium toxicity, indicating that their role is in supplying methyl groups for detoxifying selenium. The need for glycocyamine in this regard appears to vary. Creatine was again shown to be without effect in overcoming selenium toxicity. (Project 28. Leaders: C. W. Carlson, Poultry Dept., and O. E. Olson, Station Biochemistry Dept.)

The Comparative Values of Rape, Sudan Grass, and Other Forage Crops for Growing and Finishing Turkeys

Two groups of approximately 225 growing turkeys of mixed sex were transferred from Brookings to forage plots at the North Central Substation at 10 weeks of age. Alternate strips of corn and rape were planted and cultivated in one plot to be compared with Reliance sorghum and rape in the other plot. Growth of turkeys in the sorghum and rape plot exceeded that of turkeys in the corn and rape plot. This work is being repeated. (Project 79. Leaders: Wm. Kohlmeyer, R. A. Wilcox, and C. W. Carlson, Poultry Dept., and A. Dittman, North Central Substation Superintendent.)

Studies on the Effect of Antibiotics on Microflora of Chickens

There is an extensive use of antibiotics in the commercially prepared rations of chickens at present. This work contributes to the knowledge of the action of the antibiotic on the microflora of chickens.

The investigation of the effect of chlortetracycline on the growth rate of chickens has led to the consideration of subclinical infections produced by the pleuro-pneumonia-like organisms in the flock. Pleuro-pneumonia-like organisms were isolated and grown from turkeys having acute sinusitis. Chickens were inoculated with this organism and tested for the effect on weight gain with chlortetracycline.

Forty chickens were inoculated with an active culture of pleuro-pneumonia-like organisms at one month of age. Thirty of them received from 25 to 30 micrograms of chlortetracycline per pound of feed.

The birds fed chlortetracycline showed a weight gain of 87 grams per bird over the control group. None of the chickens showed clinical evidence of the chronic respiratory disease that is found in turkeys. Four weeks on the antibiotic was required to develop the maximum effect as shown by the dif-
ference in weight. (Project 257. Leaders: E. C. Berry, Bacteriology Dept.; C. W. Carlson, Poultry Dept.; and John A. Duerre, Bacteriology and Poultry Depts.)

The Development and Analysis of Improved Techniques for Marketing Poultry Products

The analysis of data obtained from a list of 1,750 egg producers was completed. Results showed that the average prices received for all eggs sold on grade were considerably higher than current receipt prices in August and November, but were only slightly higher in February and May. About half of the eggs sold in May were ungraded, compared to one third in November and February, and one fourth in August.

Gathering eggs 3 or more times daily and confinement of layers was associated with higher average prices for eggs sold on grade. Twice a week marketing was associated with higher average prices for graded eggs than once a week marketing in the spring, summer, and fall periods. Opportunities still remain for improvements to be made in marketing South Dakota eggs. (Project 175. Leaders: Wm. Kohlmeyer, Poultry Dept., and Gerald Marousek, Economics Dept.)

Effects of Inbreeding upon Economic Qualities of Chicken

Inbred lines which can reproduce by floor mating are being maintained and used for experimental crossing. The newest line to enter the testing program is SD-31. This stock, which has segregated from diverse origins, is now breeding true for several desirable characteristics—small adult body size, white egg, good egg size, and relatively early sexual maturity. The birds have a mottled plumage. Line SD-32 has been discontinued because of poor reproduction.

Selection for large and small body weight has continued in the new lines derived from an SD-21 male mated to a White Leghorn hen. The out-of-state inbred lines have been incorporated into the hybridizing program and a control stock of non-inbred White Leghorns has been imported. The latter is from the White Leghorn stock which will also be used extensively by the other states cooperating in the North Central Breeding Project. (Project 179. Leaders: Walter Morgan and William Kohlmeyer, Poultry Dept.)

Supplementation of Cereal Grains for Chickens

Preliminary data indicate that the first limiting amino acid in a diet made up largely of hulled oats and soybean meal is lysine. Replacing oats with corn (and soybean meal to keep protein constant) gave slightly better growth, but poorer feed efficiency. Growth responses to a fermentation meal, using a high energy corn-soybean type diet, have been inconsistent.

Further studies with hens have shown some advantages for the use of combinations of penicillin and the tetracyclines or nitrofurans over the use of penicillin alone in laying rations. On a 12% protein diet, sole supplements of penicillin or arsanilic acid have been detrimental whereas the combination has been of little effect. Production has not been as good on the 12% protein diet as might be expected. In cages, 16% protein seems to be adequate. The fermentation meal appears to have some effect in improving egg production. (Project 241. Leaders: C. W. Carlson and A. W. Adams, Poultry Dept., and O. E. Olson, Station Biochemistry Dept.)

Mineral Requirements of Turkeys

A low phosphorus, purified diet was fed to Beltsville Small White turkey breeder hens until egg production was reduced to about one fourth of normal. The purified diet was resorted to, since
in previous years no evidence of phosphorus deficiency was obtained by removing phosphorus supplements to the regular turkey breeder diet. Fertility of the eggs produced was not affected; however hatchability of the fertile eggs was markedly reduced. Graded levels of phosphorus were added to the purified diet as a means of establishing minimum phosphorus requirements.

Mineral requirements of poults has centered on use of a diet consisting mainly of purified soybean protein, corn sugar, pure vitamins, and minerals. Addition of sources of unidentified growth factors to this diet have been made as have the ashed residue of the sources. A water soluble fraction of soybean meal was prepared. The extracted meal gave about one half the growth of the unextracted soybean meal. The water soluble fraction is being tested for inorganic and organic growth factors. (Project 221. Leaders: R. A. Wilcox, C. W. Carlson, and Wm. Kohlmeyer, Poultry Dept., and G. F. Gastler, Station Biochemistry Dept.)

Factors Affecting the Performance of Turkeys

Although a low level of furizolidone did not consistently improve growth rate of turkeys, the results merit further consideration. High energy diets again supported faster growth rates of B.B.B. toms than low energy diets, but the native strain and one commercial strain were able to tolerate the low energy diets to a greater extent than one other commercial strain. The native strain developed a greater degree of finish at market weight, but was smaller in size and breast widths.

A study with breeder hens has confirmed our previous finding that under our conditions high levels of antibiotics in the breeder diets or supplements of fish products do not consistently affect reproductive performance. Progeny from hens fed either supplement grew faster than the control progeny, indicating carry-over of some factor through the egg. Day-old debeaking had no effect on growth rate of poults fed an adequate diet, but was detrimental on a riboflavin-deficient diet. (Project 242. Leaders: C. W. Carlson, R. A. Wilcox, A. W. Adams, Wm. Kohlmeyer, and Walter Morgan, Poultry Dept., and O. E. Olson, Station Biochemistry Dept.)

Performance Testing of Poultry

Laying-house performance for 17 experimental groups has been tested at four of the outlying substations as well as at Brookings. Some primary objectives are to determine: (1) if there is one mating-type which exceeds the others, (2) which of the inbred lines shows superior combining ability, and (3) when the inbred lines developed at this station warrant release to the state's poultrymen.

This is the first year that poultry trials have been conducted at the Newell station. Two pens of crossbreds are outperforming the purebreds, but are not doing so well as the hybrids.

At Highmore a relatively high overall production has been maintained. A pen of singlecross hens has laid the largest and the most eggs.

At Eureka the flock livability has been much better than in recent past years and a pen of experimental hybrids has produced the most eggs.

Comparisons between hens from Rhode Island Red by Barred Plymouth Rock, at Cottonwood, have laid considerably better when both parents came from inbred lines.

Although the purebred White Plymouth Rocks have shown average-good livability and good egg size, they have not laid as many eggs as have the experimental crosses at the substations and at Brookings. Inasmuch as all of the pullets being tested at Cottonwood, Eureka, and Highmore were hatched at the
same time (April 19, 1956), location effects and interactions may also be compared. (Project 287. Leaders: Walter Morgan and William Kohlmeyer, Poultry Dept.)

Sex Reversal Studies of the Fowl

In addition to continuing chick ovary removal, testis tissue was transplanted under the skin of several operated chicks. The presence of this masculine tissue, which was taken from young chicks hatched from parents similar to the operated chicks, did not appear to effect additional male-like changes. Within 3 weeks the foreign tissue was usually resorbed.

In one instance, an intact testis which was placed inside the body cavity of an operated pullet was found at autopsy. The testis had grown in proportion to the growth of the bird; it was approximately the size of a normal adult testis. Distinct spermatozoa were being produced in the testis, but no connecting tube leading to the cloaca could be identified.

Matings of the most masculine appearing adults with virgin pullets did not produce fertile eggs. Although an occasional bird appeared aggressive, there was no observed treading, despite the hens' invitations.

Publication: “Can We Produce All Pullet Chicks?” South Dakota Farm and Home Research, August 1957, Vol. VIII, No. 4, pp. 8-11. (Project 289. Leader: Walter Morgan, Poultry Dept.)

Maintaining Quality of Turkey Meat in Market Channels

Keeping quality of turkey carcasses with greater skin-fat content was not greatly different from those with lesser skin-fat content. These differing types of carcasses were obtained by feeding high energy diets which gave carcasses of greater skin-fat content and low energy diets which gave the lesser skin-fat. Muscle fat was not consistently affected by diet. Keeping quality was determined by palatability of carcass halves roasted before and after six months of frozen storage and scored for flavor, tenderness, and juiciness.

As before, carcasses of toms kept better than those of hens as evidenced by less decline in organoleptic scores. Carcasses of toms from a group produced on a low energy diet without antibiotics had drip fat with the lowest peroxide content after storage and were preferred by the taste panel on the overall basis by a large majority. These carcasses also had the least amount of skin fat, but did not rank consistently above the others in organoleptic scores. (Project 261. Leaders: C. W. Carlson, Poultry Dept.; Lida M. Burrill, Home Economics dept., and O. E. Olson, Station Biochemistry Dept.)

Also see: Floor Plate Brooder, page 2 

Farmers get first-hand information on latest research results by attending field days.
Rural Sociology Projects

Rural Life

Retirement and Health Problems of Rural Families in South Dakota
This project is designed to determine the retirement and health problems of rural families in South Dakota. The phase being investigated at this time is the problem of the aged (65 years and over) from the sociological point of view. The interviewing of the older people in a selected South Dakota community has been completed and the analysis of the data will be started shortly. A questionnaire has been prepared for mailing to a selected group of individuals throughout the state who are in strategic positions regarding the problems of the aged people of our state. A bulletin based on the information gathered is planned for the coming year. (Project 279. Leaders: G. A. Kristjanson and Howard M. Sauer, Rural Sociology Dept.)

Selected Factors Influencing Adjustment of Indians in the Rural Areas of South Dakota
The background information on the Dakota Indian culture was analyzed and summarized in a pamphlet, "Acculturation of the Dakota Indians," for distribution to county Extension agents, Indian Bureau personnel, and others in the state who are working with Indian people.

Field work investigating the characteristics of the Indian family was started in two communities at Kyle and Oglala on the Pine Ridge Reservation. The use of community research methods, including direct observations, questionnaires, sociometric diagrams, and statistical analyses, have provided some tentative conclusions which are essential to an understanding of the family organization of the Dakota Indians. (Project 273. Leader: Vernon D. Malan, Rural Sociology Dept.)

The Socio-Economic Influences of the Communal Type Farm on the Rural Community in South Dakota
The Hutterite colonies in South Dakota exemplify one form of communal farm organization. The first phase of the research on this type of farm organization is designed to include a consideration of the origin and development of the Hutterite conception of communal living, and the settlement, increase in number, and the present location of Hutterite communal farms in South Dakota. Main findings from this phase of the research provided the basis for the article, "Communal Farmers: The Hutterite Brethren," appearing in the November 1956 issue of South Dakota Farm and Home Research.

Findings from this phase of the study fail to support the popular conception that the trend in the number of Hutterite communal farms in South Dakota has been one of steady increase since their original settlement in the 1870's. Instead of a steady increase, the total number of communal farms of this type shows considerable fluctuation when viewed from the perspective of three historical periods. The period from 1874 to 1913 was marked by a steady increase in the number of Hutterite colonies.
until at the end of the period there were 17; the second period, 1918 to 1934, was a time of decline in number due to the migration of whole colonies to Canada (only one colony remained in South Dakota in 1934); and the final period, 1935 to 1955, has been characterized by a steady increase in the number until in 1955 there were once again 17 colonies in South Dakota. (Project 255. Leader: Marvin Riley, Rural Sociology Dept.)

Impact of Population Changes Upon South Dakota Rural Communities

The current phase of this project deals with the analysis of problems resulting from the population changes including changes in characteristics of the rural population and industrial condition which give rise to rural-urban migration. Included in this study will be an analysis of the effect of rural-urban migration on the social and economic life of rural people by ascertaining the nature and mode of institutional adjustment (for example, schools, churches, health and medical services, and rural-urban organizations); and studying the motivating factors and decision-making process of in-migrants. This study will be conducted in a county in South Dakota which is characterized by: (1) high out-migration; (2) low level of living; and (3) low proportion of the population employed in manufacturing. Field interviews will be used to determine the community background, community institutional systems (describe them, note changes, and report attitudes), and the social adjustment of persons as an indication of the situation that led to migration. Field work for this study will be started in July of this year. (Project 222. Leader: G. A. Kristjanson, Rural Sociology Dept.)

Station Biochemistry Projects

Chemistry in Farming

Nitrate Poisoning

Nitrate reduction is being studied using the "artificial-rumen" technique. Nitrogen in the form of nitrate or nitrite has been incubated with samples of rumen liquid. To these samples certain compounds have been added to test their effect on the rate of nitrate and nitrite reduction. Some of these compounds have been found to be very effective in removing nitrite found during the fermentation of nitrate, or in affecting the rate of nitrate reduction.

The nature of these effects (are they chemical or biochemical?) is the subject of present investigation.

Sugar beet seedlings were supplied several levels of nitrate nitrogen and sprayed with three different amounts of 2,4-D. Nitrates accumulated in nearly the same amounts in all of the sprayed plants, regardless of the level of nitrogen supplied or the amount of spray used. (Project 87. Leaders: E. I. Whitehead and R. J. Emerick, Station Biochemistry Dept.)
Farm and Home Water Quality

Evaluations were made on coffee and tea brewed from 23 different waters from various sources in the state and from the same waters after softening. The softened water made clearer tea, but in all other respects the hard waters were superior.

In laundry studies, tea towels were laundered 25 times after use in waters of varying hardness. Soap and softeners were used on some, a detergent on others. Different types of bleaches were also used. Whiteness retention, thickness, weight, breaking strength, and elongation measurements are now being made.

A study of the salinity of dugout waters was completed and the results have been published. Work on desalting water was halted when the equipment built was burned in the Agricultural Engineering building fire.


Selenium Poisoning

At Reed Ranch, two experiments on the effect of arsanilic acid on selenium poisoning were completed. Some protection was observed in both trials. Further work is necessary to establish the practicability of this control measure for cattle. A similar experiment with brood sows has been in progress since fall. When farrowing is complete it will be possible to determine what effects arsanilic acid will have in preventing any reproductive disturbances caused by selenium.

In the laboratory, further progress has been made in the purification of the protective principle present in linseed oil meal. A crystalline compound obtained from an active, purified fraction is now being tested on rats. In other studies with these animals, it has been found that seleniferous diets of high fat content but containing little carbohydrate are less toxic than diets containing some carbohydrate. This finding may have no practical significance, but it is of importance in our understanding of why selenium is toxic. (Project 19. Leaders: O. E. Olson, A. W. Halverson and E. I. Whitehead, Station Biochemistry Dept.; and C. A. Dinkel, J. R. Minyard and R. C. Wahlstrom, Animal Husbandry Dept.)

Chemical Analysis of Grass Silage Under Different Methods of Storage

Losses of nutrients from corn silage (about 120 tons per silo) stored in a stack, a conventional upright, and a gas-tight silo were investigated. Only about one-half of the dry matter originally put into the stack was preserved in edible form. In the case of the upright, four-fifths was preserved while with the gas-tight silo over nine-tenths was preserved. There was no spoilage in the gas-tight silo, about 8% spoiled in the upright, and 28% in the stack. The remainder in each case was lost largely through fermentation.

In a large (155-ton) stack of sorghum silage, 65% of the dry matter was recovered in edible form. The greater recovery in this case resulted from its being a larger stack and from the fact that it was fed at a slower rate. This allowed for a greater consumption of spoilage than was the case with corn silage. (Project 237. Leaders: A. W. Halverson and O. E. Olson, Station Biochemistry Dept.)

Also see:

Possible Toxic Effects on Plants of Iron Laden Water Which is Transported through Aluminum Pipe for Sprinkler Irrigation Purposes, page 2
Handling, Storing, and Feeding of Grass Silage, page 17
Nutritive Values of Grasses and Hays of
Veterinary Projects

Livestock and Poultry Diseases

**Leptospirosis of Farm Animals**

Leptospirosis is an infectious disease of cattle and swine which has reached great economic importance in many states. *Leptospira pomona*, a spirochete, is the cause in these species of farm animals. On a survey by means of serological tests, the incidence of *L. pomona* infection in South Dakota cattle was 4.7% and in swine, 3.14%. The disease is being studied both in naturally infected herds and in experimentally produced cases to better understand the pathology and means of spread. (Project 270. Leaders: G. S. Harshfield and John McAdaragh, Veterinary Dept.)

**Mucosal Disease of Cattle**

Mucosal disease has occurred in several widely separated herds in this state since 1952, and attempts are being continued to reproduce the disease and find the definite cause. An infectious agent present in some natural cases has produced mild symptoms in experimental calves but it has not produced the high mortality associated with the disease in farm herds. The possibility that some stress factor is associated with an infectious agent is being investigated. (Project 253. Leader: G. S. Harshfield, Veterinary Dept.)

**The Control of Fowl Cholera**

Fowl cholera is one of the oldest of the poultry diseases, yet completely satisfactory measures of control are lacking. The biochemical and antigenic characteristics of the fowl cholera organism, *Pasteurella multocida*, are being studied as one approach to the control problem. Differences are found...
between strains recovered from natural outbreaks. (Project 141. Leader: T. A. Dorsey, Veterinary Dept.)

Sporadic Bovine Encephalomyelitis
This disease continues to appear in an occasional cattle herd in the state but mortality has been low in the outbreaks investigated this year. Technical Bulletin 18, *Sporadic Bovine Encephalomyelitis*, has been prepared, bringing together present information on the disease. (Project 171. Leader: G. S. Harshfield, Veterinary Dept.)

**PUBLICATIONS AND JOURNAL ARTICLES**

**Bulletins**


**Circulars**

*The Economic Strength of South Dakota's Agriculture as Measured by Farm Mortgage Foreclosures.* Circular 132, by Gabriel Lundy and R. L. Berry.

*Organizing for Watershed Development.* Circular 133, by John Muehlbeier.


*Parakeratosis, A Nutritional Disease of Swine.* Circular 137, by Richard C. Wahlstrom.


**Technical Bulletin**

Journal Articles Submitted for Publication

**Agronomy**


**Animal Husbandry**


**Entomology-Zoology**


**Home Economics**


**Poultry**


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Experiment Station Staff

Regents of Education

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<td>Ephriam Hixson, Ph.D.</td>
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Agricultural Engineering

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Animal Husbandry

<table>
<thead>
<tr>
<th>Name</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. L. Musson, Ph.D.</td>
<td>Animal Husbandman</td>
</tr>
<tr>
<td>L. F. Bush, Ph.D.</td>
<td>Associate</td>
</tr>
<tr>
<td>C. A. Dinkel, Ph.D.</td>
<td>Associate</td>
</tr>
<tr>
<td>L. E. Dubose, M.S.</td>
<td>Assistant</td>
</tr>
<tr>
<td>Roy D. Dukhary, B.S.</td>
<td>Assistant</td>
</tr>
<tr>
<td>L. B. Embry, Ph.D.</td>
<td>Animal Husbandman</td>
</tr>
<tr>
<td>F. R. Gartner, M.S.</td>
<td>Associate</td>
</tr>
<tr>
<td>L. D. Kamstra, Ph.D.</td>
<td>Associate</td>
</tr>
<tr>
<td>Paul H. Kohler, M.S.</td>
<td>Associate</td>
</tr>
<tr>
<td>J. K. Lewis, M.S.</td>
<td>Assistant</td>
</tr>
<tr>
<td>R. M. Luthers, B.S.</td>
<td>Assistant</td>
</tr>
<tr>
<td>J. W. McCarty, M.S.</td>
<td>Associate</td>
</tr>
<tr>
<td>W. C. Mccone, M.S.</td>
<td>Associate</td>
</tr>
<tr>
<td>J. A. Minyard, B.S.</td>
<td>Assistant</td>
</tr>
<tr>
<td>R. C. Wahlstrom, Ph.D.</td>
<td>Associate</td>
</tr>
<tr>
<td>C. P. Wilder, M.S.</td>
<td>Assistant</td>
</tr>
<tr>
<td>Turner Wright, B.S.</td>
<td>Emeritus Animal Husbandman</td>
</tr>
</tbody>
</table>

Agronomy

<table>
<thead>
<tr>
<th>Name</th>
<th>Title</th>
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</thead>
<tbody>
<tr>
<td>W. W. Worzelka, Ph.D.</td>
<td>Agronomist</td>
</tr>
<tr>
<td>M. W. Adams, Ph.D.</td>
<td>Agronomist</td>
</tr>
<tr>
<td>Joseph J. Bonnemann, B.S.</td>
<td>USDA Agent, Agronomist</td>
</tr>
<tr>
<td>B. L. Brage, Ph.D.</td>
<td>Associate</td>
</tr>
<tr>
<td>G. J. Bentley, M.S.</td>
<td>Assistant</td>
</tr>
<tr>
<td>Paul L. Carson, M.S.</td>
<td>Associate</td>
</tr>
<tr>
<td>R. Bonestell, B.S.</td>
<td>Assistant</td>
</tr>
<tr>
<td>L. A. Derscheid, Ph.D.</td>
<td>Associate</td>
</tr>
</tbody>
</table>

52
V. A. Dirks, M.S.         Associate
L. O. Fine, Ph.D.         USDA Agent, Agronomist
C. J. Franzke, B.S.      Agronomist
D. D. Harstead, M.S.     Assistant
A. N. Humf, Ph.D.        Emeritus Agronomist
Q. S. Kingsley, B.S.     Assistant
D. E. Kratochvil, M.S.   Assistant
R. A. Moore, B.S.        Assistant
PHILIP PRICE, Ph.D.      (USDA) Assistant
L. F. Puhp, Ph.D.        Agronomist
J. G. Ross, Ph.D.        Agronomist
J. R. Runkes, Ph.D.      Assistant
MARY E. SANDERS, Ph.D.  Res. Associate
D. B. Shank, Ph.D.       Agronomist
F. E. Shubek, Ph.D.      Associate
C. R. SWANSON, Ph.D.     (USDA) Associate
H. M. VANCE, B.S.        Assistant
FRED C. WESTIN, Ph.D.    Agronomist
E. M. WHITE, Ph.D.       Associate
FRANK WIERMA, M.S.      Assistant
L. P. WILDING, B.S.      Assistant

Bacteriology

E. C. Berry, Ph.D.       Bacteriologist

Dairy

D. F. BREAZEALE, Ph.D.   Dairy Husbandman
R. J. BAKER, Ph.D.       Associate
EMERY BARTLE, M.S.      Assistant
A. E. DRACY, Ph.D.       Associate
S. W. SEAS, B.S.         Res. Assistant
H. H. VOELKER, Ph.D.    Assistant

Economics

MAX MYERS, Ph.D.        Economist
LIMEN T. SMYTHE, M.A.   Acting Head
RUSSELL L. BERRY, M.S.  Associate
CHAS. H. BENNET, M.S.   Assistant
ALLEN R. CLARK, M.S.    Assistant
LOYD GLOVER, Ph.D.      Associate
R. HELFSTINE, M.S.      (USDA) Economist
R. E. JOHNSTON, B.S.    (USDA) Economist
R. L. KRISTJANSON, Ph.D.Assistant
R. H. KRUSE, M.S.       Assistant
G. LUNDY, M.S.          Economist
T. W. MANNING, Ph.D.    Associate
G. E. MAROUSER, M.S.    Assistant
A. L. PAULICK, M.S.     Assistant
R. F. PENGRA, M.S.      Assistant
JOHN E. THOMPSON, M.S.  Assistant
W. K. ULMAN, M.S.       Assistant
P. W. VANVLACK, Ph.D.   Associate

Entomology-Zoology

G. B. SPAWN, Ph.D.      Entomologist
E. J. HUGHINS, Ph.D.    Associate
WM. M. ROGOFF, Ph.D.    Entomologist
H. C. SEVERIN, M.A.     Emeritus Entomologist
R. J. WALTROM, Ph.D.    Assistant

Home Economics

FRANCES M. HEYTLER, Ph.D. Home Economist
E. BETH ALSUP, M.S.    Associate
LIDA M. BURRELL, Ph.D.  Home Economist
LILLIAN O. LUND, M.S.   Associate

Horticulture

S. A. McCrory, M.S.     Horticulturist
P. E. Collins, M.S.     Associate
R. L. Nickerson, Ph.D.  Assistant
R. M. Peterman, Ph.D.   Associate
J. M. Rawson, Ph.D.     Assistant

Plant Pathology

C. M. Nagel, Ph.D.      Plant Pathologist
J. F. Henness, Ph.D.    Assistant
C. J. Manahan, Ph.D.    Associate
MERRIL MICHAELSON, Ph.D. (USDA) Assistant
R. E. OCHS, Ph.D.       Assistant
GEO. SEMENIUK, Ph.D.   Pathologist
L. W. Wood, M.S.       (USDA) Assistant

Poultry

WM. KOHLMEYER, M.S.    Poultry Husbandman
A. W. ADAMS, M.S.       Assistant
C. W. CARLSON, Ph.D.    Poultry Husbandman
W. C. Morgan, Ph.D.    Associate
R. A. Wilcox, M.S.     Assistant

Publications

E. W. METCALF, M.S.    Station Editor

Rural Sociology

H. M. Sauer, M.A.       Acting Sociologist
G. A. Kristjan, M.S.    Assistant
V. D. Malan, Ph.D.      Associate
M. P. RILEY, M.S.       Associate

Station Biochemistry

O. E. Olson, Ph.D.     Chemist
C. W. Bonhert, Ph.D.    Associate Biochemist
WILLARD R. BRONZ, B.S.  Res. Assistant
R. J. EMERICK, Ph.D.    Assistant Biochemist
GEO. F. GASTLER, M.S.  Assistant Chemist
A. W. HALVERSON, Ph.D.  Associate Biochemist
VOLNEY WALLACE, Ph.D.  Assistant Biochemist
E. J. WHITEHEAD, M.S.  Associate Chemist

Veterinary

G. S. Harshfield, D.V.M., M.S. Veterinarian
T. A. DORSEY, D.V.M.   Associate
I. L. GRAVES, Ph.D.     Assistant
JOHN McADARAGH, B.S.  Assistant
J. B. TAYLOR, V.M.D.   Associate

Substations

FRANK W. WHETZAL, Superintendent
Range Field Station, Cottonwood
ALBERT DITTMAN, Superintendent
North Central Substation, Eureka
WADE R. PRINGLE, Superintendent
Central Substation, Highmore
NIEL A. DIMICK, Superintendent
U. S. Newell Irrigation and Dryland Field Station, Newell
W. H. TREVILLYAN, Superintendent
Antelope Range Field Station, Buffalo
JAMES D. RAIN, Superintendent
Reed Ranch, Presho
# Staff Resignations and Appointments

## Resignations

<table>
<thead>
<tr>
<th>Department</th>
<th>Name</th>
<th>Position</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agronomy</td>
<td>Frank Wiersma</td>
<td>Assistant Agronomist</td>
<td>March 11, 1957</td>
</tr>
<tr>
<td>Economics</td>
<td>Ottar Nervik</td>
<td>Economist</td>
<td>July 1, 1956</td>
</tr>
<tr>
<td>Home Economics</td>
<td>E. Beth Alsup</td>
<td>Associate Professor of Research</td>
<td>October 1, 1956</td>
</tr>
<tr>
<td>Station Biochemistry</td>
<td>C. W. Bonhorst</td>
<td>Associate Biochemist</td>
<td>September 1, 1956</td>
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## Retirement

<table>
<thead>
<tr>
<th>Department</th>
<th>Name</th>
<th>Position</th>
<th>Date</th>
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</thead>
<tbody>
<tr>
<td>Administration</td>
<td>I. B. Johnson</td>
<td>Director of Experiment Station</td>
<td>July 1, 1956</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(Assistant to the Chief now on leave of absence)</td>
<td></td>
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## Appointments

<table>
<thead>
<tr>
<th>Department</th>
<th>Name</th>
<th>Position</th>
<th>Date</th>
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<tbody>
<tr>
<td>Administration</td>
<td>Ephriam Hixson</td>
<td>Acting Director of Experiment Station</td>
<td>July 1, 1956-January 15, 1957</td>
</tr>
<tr>
<td></td>
<td>Max Myers</td>
<td>Director of Experiment Station</td>
<td>January 16, 1957</td>
</tr>
<tr>
<td>Agricultural Engineering</td>
<td>D. D. Hamann</td>
<td>Assistant Agricultural Engineer</td>
<td>August 15, 1956</td>
</tr>
<tr>
<td>Agronomy</td>
<td>R. A. Moore</td>
<td>Assistant Agronomist</td>
<td>July 1, 1956</td>
</tr>
<tr>
<td></td>
<td>L. P. Wilding</td>
<td>Assistant Agronomist</td>
<td>July 1, 1956</td>
</tr>
<tr>
<td>Animal Husbandry</td>
<td>F. R. Gartner</td>
<td>Assistant Animal Husbandman</td>
<td>July 1, 1956</td>
</tr>
<tr>
<td></td>
<td>Robert Duxbury</td>
<td>Assistant Animal Husbandman</td>
<td>July 1, 1956</td>
</tr>
<tr>
<td>Economics</td>
<td>A. M. Pavlick</td>
<td>Assistant Economist</td>
<td>July 1, 1956</td>
</tr>
<tr>
<td></td>
<td>P. W. VanVlack</td>
<td>Associate Economist</td>
<td>August 1, 1956</td>
</tr>
<tr>
<td></td>
<td>T. W. Manning</td>
<td>Associate Economist</td>
<td>January 1, 1957</td>
</tr>
<tr>
<td></td>
<td>Limen T. Smythe</td>
<td>Acting Head of Economics Department</td>
<td>May 1, 1957</td>
</tr>
<tr>
<td>Horticulture</td>
<td>R. L. Nickelson</td>
<td>Assistant Horticulturist</td>
<td>July 1, 1956</td>
</tr>
<tr>
<td>Rural Sociology</td>
<td>G. A. Kristjanson</td>
<td>Associate Sociologist</td>
<td>September 1, 1956</td>
</tr>
<tr>
<td>Station Biochemistry</td>
<td>Willard R. Brosz</td>
<td>Research Assistant</td>
<td>September 1, 1956</td>
</tr>
<tr>
<td></td>
<td>R. J. Emerick</td>
<td>Assistant Biochemist</td>
<td>January 1, 1957</td>
</tr>
<tr>
<td>Veterinary</td>
<td>I. L. Graves</td>
<td>Assistant Veterinarian</td>
<td>July 1, 1956</td>
</tr>
</tbody>
</table>
# Financial Report—Agricultural Research Funds—July 1, 1956 to June 30, 1957

<table>
<thead>
<tr>
<th></th>
<th>Federal Research Funds</th>
<th>State Research Funds</th>
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<tbody>
<tr>
<td></td>
<td>Hatch</td>
<td>Regional Research</td>
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<tr>
<td><strong>Appropriation</strong></td>
<td>$302,878.00</td>
<td>$74,950.00</td>
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<tr>
<td><strong>Balance on Hand, July 1, 1956</strong></td>
<td>—</td>
<td>—</td>
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<tr>
<td><strong>Sale Proceeds</strong></td>
<td>—</td>
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<tr>
<td><strong>Rental</strong></td>
<td>—</td>
<td>—</td>
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<tr>
<td><strong>TOTAL</strong></td>
<td>$302,878.00</td>
<td>$74,950.00</td>
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**EXPENDITURES**

<table>
<thead>
<tr>
<th></th>
<th>Hatch</th>
<th>Regional Research</th>
<th>Title II</th>
<th>Experiment Station</th>
<th>Experiment &amp; Substation</th>
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<tbody>
<tr>
<td><strong>Personal Services</strong></td>
<td>$177,521.51</td>
<td>$48,066.31</td>
<td>$6,598.68</td>
<td>$345,000.00</td>
<td>$45,269.75</td>
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<tr>
<td><strong>Travel</strong></td>
<td>7,628.44</td>
<td>4,098.54</td>
<td>410.13</td>
<td>7,474.87</td>
<td>10,564.25</td>
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<tr>
<td><strong>Transportation of Things</strong></td>
<td>194.03</td>
<td>32.61</td>
<td>—</td>
<td>4,538.29</td>
<td>2,564.82</td>
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<tr>
<td><strong>Communication Service</strong></td>
<td>460.49</td>
<td>80.45</td>
<td>12.18</td>
<td>2,654.15</td>
<td>3,985.55</td>
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<tr>
<td><strong>Rents and Utility Services</strong></td>
<td>647.54</td>
<td>736.86</td>
<td>—</td>
<td>2,458.31</td>
<td>2,878.55</td>
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<tr>
<td><strong>Printing and Binding</strong></td>
<td>10,210.81</td>
<td>178.63</td>
<td>7.98</td>
<td>5,893.28</td>
<td>1,646.87</td>
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<tr>
<td><strong>Other Contractual Service</strong></td>
<td>8,164.91</td>
<td>5,398.99</td>
<td>—</td>
<td>17,435.71</td>
<td>21,283.79</td>
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<tr>
<td><strong>Supplies and Materials</strong></td>
<td>44,777.53</td>
<td>11,368.71</td>
<td>319.46</td>
<td>53,020.02</td>
<td>74,960.06</td>
</tr>
<tr>
<td><strong>Equipment</strong></td>
<td>20,988.64</td>
<td>4,988.90</td>
<td>862.98</td>
<td>40,525.37</td>
<td>38,077.56</td>
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<tr>
<td><strong>Land (Non-structural improvement)</strong></td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
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<tr>
<td><strong>TOTAL</strong></td>
<td>$302,878.00</td>
<td>$74,950.00</td>
<td>$8,809.57</td>
<td>$479,000.00</td>
<td>$201,231.20</td>
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<tr>
<td><strong>Unexpended Balance, July 1, 1957</strong></td>
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<td>—</td>
<td>—</td>
<td>—</td>
<td>70,372.21</td>
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<tr>
<td><strong>GRAND TOTAL</strong></td>
<td>$302,878.00</td>
<td>$74,950.00</td>
<td>$8,809.57</td>
<td>$479,000.00</td>
<td>$271,603.41</td>
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</table>